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MECHANICAL AND PHYSICAL SCIENCE,

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AND THE RECORDING OF

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JANUARY, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

The Bar at the Mouth of the Mississippi River.

By D. S. Howard, Civ. & Marine Eng.

The vast importance of this impediment to the trade of one of the greatest commercial thoroughfares in the world, together with the other incalculable evils arising out of the freshets of this river alone, is well calculated to demand from an enlightened people a remedy, which may also be applied to numerous similar obstructions to navigation in other streams that have existed ever since the world began, and will ever exist until the subject shall have received the attention due to it.

There is no improvement within the reach of science of the same importance, that has so baffled the research of scientific men as that of rivers and harbors. Still, there is no reason to despair, for "necessity is the mother of invention," and we may look upon the bar at the mouth of the Mississippi, as a near relative to necessity, if not the real parent of some invention that will free the world, not only of bars at the mouths of rivers, but from various other obstructions above, as far as the current will admit of navigation without locks.

The invention, in fact, has already been made; but, in a republican government like ours, where a majority of the whole people have to sanction the policies adopted by the government, it is necessary that every subject of so much importance as this, should be thoroughly discussed before any great deviation can be made from the beaten track,

however unsuccessful we may hitherto have been in it. It, therefore, behooves us all to search among the established facts of the case for a true remedy.

If the remedy be found in any invention already made, let the arguments be put forth sustaining it by every advocate for the improvement of our country, the advancement of commerce, and justice to the bold originator of the plan, that it may be applied before the governments of Europe, or some power not dependent upon the people to sanction their policies, adopt the honor as well as the profit of a project so important to the world at large.

The newspapers are already bringing out Napoleon III. as the projector of "artificial lakes for the improvement of the Loire and other rivers of France," and, at the same time, say that "it has been suggested for the improvement of the Ohio," without mentioning the name of the man who suggested it.

We may here observe a prevailing disposition in human nature to make royalty the centre of greatness in the useful arts and sciences, as well as those of politics and war, by clothing it with the happy thoughts and suggestions of the more humble searchers after scientific truths. This would seem to be among the moral evils, but, if so, it is one out of which great good is often produced.

The weakest ruler knows enough of human nature to expect the clamorous applause of the weak and designing part of his people, for all the great designs he may be instrumental in carrying out, whether he be the originator of them or not; but that portion of mankind whose applause is of any value are ready to do justice to the real projector also. Many great projects are thus carried out through the influence of concentrated political power that might never have come to light by any other means, until the originators were beyond the reach of benefit from them.

Napoleon III., in adopting this plan, would manifest more discernment, more magnitude of purpose, and more ability to become great among a scientific people, than is common to heads of governments of any kind.

We have the facts and figures before us, from a source we have a right to respect as the best authority, countenanced by the highest scientific ability in that department of the nation, which show beyond a peradventure that one of the main tributaries of the Mississippi may be placed under perfect control by the expenditure of a small sum of money compared to the amount of property (saying nothing about the lives) lost at every great freshet. These figures also show that the perfect control over the freshets of the Ohio river, would have kept the waters within the levees on the lower Mississippi, through the two last great freshets, which would have saved enough to have made a good beginning towards improving all of the other principal tributaries, and securing the whole system of rivers against any serious damages from flood forever, besides the untold amount of benefit from the improvement of their navigation.

There is always good water over the bar at the mouth of the river

at any and all times when the river is confined within its banks. It is only when the freshets of the numerous tributaries act sufficiently in unison to cause an overflow of the levees, that the deposit at the mouth becomes troublesome. This fact, alone, shows conclusively that the whole evil is due to the additional amount of sediment produced by the freshets; and, though lateral outlets could be produced sufficient to relieve the levees and enable them to confine the remainder of the water, the navigation would still be obstructed. The only benefit of the lateral outlets would be the saving of swamp lands.

Another important fact is, that nature has provided better for the true remedy of *all* the evils arising out of the overflow of the Mississippi than of most other rivers. All who have explored its head waters bear testimony to it. The facilities for reservoirs are seldom surpassed. The country is filled with lakes and ponds.

The question has been raised (and strange to say by professed engineers, who, however, are opposed to the reservoir system,) against the usefulness of reservoirs without the expense of constant attendance to regulate them. It is true that a limited number may be made more useful if attended to and drawn off at proper times, but common observation might teach us the usefulness of reservoirs without attendance, by comparing such rivers as have natural reservoirs with those that have not, as the upper Mississippi with the upper Missouri. The one heads in numerous rice-lakes and swamps, and the other in the narrow valleys of the Rocky Mountains. The one is a gentle, pure, crystal stream until joined by some of its turbulent tributaries, and the other is a wild, furious stream, subject to be influenced by every rain or season of melting snow, causing freshets that change the current of the stream and wash away the banks, tearing up trees, and furnishing materials for bars, rafts, snags, and sawyers; and, when acting in concert with other similar streams in the same great basin, produce the great freshets that overflow the levees on the lower Mississippi, causing great destruction of property, enough at every such freshet, if properly applied, to establish the fact at least, that the reservoir system is the only true system for the improvement of rivers.

We may also compare the magnificent St. Lawrence with any other river of the opposite character; there is not one of the three hundred thousand square miles of this great basin that would not warrant cultivation so far as the climate is concerned. There are no parched deserts or inundated swamp lands to reclaim. Although there are many turbulent little streams among the head waters of this noble river, the natural reservoirs are so extensive and their surfaces bear such a proportion to the width of their outlets, that any rush of water from any combination of causes, is swallowed up without causing any sudden rise in the river below.

It is wholly unnecessary to include in estimates of the reservoir system a large item of expense for attendance after the reservoirs are built if the work be properly and permanently done. The outlets of each reservoir should have a width proportional to the amount of water to be discharged, and the height of the dam, which should never be

overflowed; then, the greater the proportion which the area of the surface of the reservoir bears to that of the water-shed, the nearer perfect will be the regimen of the river below.

One of the beauties of the reservoir system is, that any amount of money, however small, if properly expended, creates an immediate corresponding permanent benefit, which is well calculated to encourage the completion of the system.

It is no part of my purpose here to set forth the numerous advantages of the reservoirs in a country where the streams below require them. We have only to turn the American mind from speculations of far less importance, by showing the possibility of complete success, at a moderate comparative cost.

It would seem to be an easy matter of calculation to determine the comparative cost of retaining the surplus waters of the Mississippi near its source in spacious reservoirs, and confining them by levees less than one mile apart, and over a thousand miles long, each.

Where natural reservoirs do not exist among the numerous tributaries to the Mississippi, it is not being over-trustful to rely upon a diversified country containing a million or more of square miles, the extent of the great water shed of this river, to afford facilities for reservoirs better than the bed of the lower part of the river, where there are no materials but mud and perishable timber afforded for structures which, when constructed, are not only liable to be worn away by the various freaks of the current at different stages of the flood, but are subject to destruction at any time by the numerous animals that burrow in the banks near the surface of the water.

The amount of dike required to keep the surplus waters of any river back, if built along the banks of the upper streams without regard to the best locations for reservoirs, would bear the same proportion to the levees inversely, as the land overflowed by the dikes, to the surface of the stream enclosed by the levees. This brings the subject fairly before us. To all who have had occasion to observe the features of rivers and river basins, it is conclusive, that in no case can it cost as much to retain the surplus waters of any river or that amount which overflows the banks, by reservoirs above, as by levees below. It is also evident that locations may be selected somewhere within the great basin of any principal stream, that will not only reduce the expense of dams and dikes, but lessen materially the land to be overflowed.

It is well known that the land along rivers which empty into the ocean is valuable in proportion to its proximity to the coast generally, both on account of the quality of the soil, and the convenience of getting its products to market. The climate is also different, in favor of the lower waters, unless where nature, in a seeming desire to give us a useful hint, has supplied the country at the source of some few streams, such as the Oswego river in New York, the river Trent in Canada, and some of the other principal tributaries to the St. Lawrence, which bear incontrovertible testimony to the correctness of the policy of sacrificing the land necessary at or near the source, for the benefit of that and other property nearer the mouth of a river.

From a careful consideration of the admitted facts of the case, it is evident that nothing short of the reservoir system will ever be perfectly satisfactory to the aggregate interest in the Mississippi river. In the meantime something must be done for the commercial interests immediately.

In February last, the New Orleans Chamber of Commerce reported that five millions and a half of dollars worth of property was held in check, at one time, by the bar at the mouth of the river. I am confident this is no exaggeration, as I counted sixty-seven three-masted vessels at anchor near the bar, inside and out, and aground on it, at the South-west Pass, on the morning of the twenty-fourth of the same month, the most of which were undoubtedly detained by the vast accumulation of sediment. The river was then overflowing its banks and levees at near the highest point ever reached.

The only means for immediate relief are dredging and scouring. Dredging was resorted to in 1839, by Capt. A. Talcott, one of the ablest engineers ever in the U. S. service, under very unfavorable circumstances; but, had he possessed the advantages of the improved machinery now in use, he would have been eminently successful, as he usually is in all of his undertakings, more especially in the improvement of rivers and harbors.

In a very able report to the Chamber of Commerce of New Orleans by A. J. Duncan, in February last, a plan of dredging and scraping is recommended, such as has been tried with some success, but it would seem that a more economical use of power might be made by raising the material and depositing it on each side of a three hundred feet channel, which could be done without lighters by improved machinery already tested: the cost of outfit would be no more than that for dredging and scraping, and the cost of working much less. By these means the current in the channel would be increased by the deposit on the side; while, with wings recommended by Mr. Duncan so constructed as to increase the current near the bottom, and a proper construction of the lower machinery of the dredge for stirring up the mud, as much would be carried off by the current as when the drag and scraper are used, with much less power, besides what is raised and deposited outside the three hundred feet.

The possibility of depositing the excavated material one hundred and fifty feet from where it is raised without lighters, might be questioned were it not that machines are now in operation in similar and less favorable material, which is readily discharged by a spout inclined less than an inch to the foot.

If it should be objectionable to make any deposit on the sides of the channel, a machine should be constructed capable of carrying within itself one hundred cubic yards or more, with the lower machinery calculated for stirring up the mud while excavating, which may be gauged to load itself while passing from deep water above to deep water below, where the load would be discharged and the dredge returned by means of a propeller screw, worked by the same power.

On this plan, it is estimated that with an outfit of $50,000 and an

expense of $175 per day of 24 hours, 8000 cubic yards could be re moved daily from the bar and deposited in the Gulf, which would admit of a liberal allowance for contingencies, and bring the whole cost below $100,000 for removing 900,000 cubic yards within six months, the amount required from the South-west Pass and Pass-à-l'Outra; making twenty feet depth, with a width of three hundred feet in each channel.

Corpus Christi, Texas, June, 1859.

Steam Engineering in 1859.* *Steam Generation* (*Continued*).

(Continued from Vol. xxxviii, page 366.)

In our last number we referred briefly to the present efficiency of boilers used on land, and pointed out the wide margin still left for improvement; and as it is neither the intention nor object of these general observations to enter minutely into constructive details, we propose now, as briefly, to say a few words respecting the present efficiency of marine boilers.

When steam was first applied to the propulsion of ships, it was generated in large boilers with capacious internal flues, the pressure per sq. in. seldom exceeding 4 or 5 lbs. The advantages of this class of boilers are the ready access to all portions of the internal surface for cleaning, and their consequent durability, extending frequently to 8 and 10 years; their disadvantages are their weight, both of iron and water, and the great space they occupy in the ship. They have been, and still are, much used for tug-boats, and a few may be found in some of our largest first-class steamships.

To remedy the great weight and bulk of the flued boiler, the multitubular system was introduced, and it has now almost completely supplanted all other kinds of boilers for steamships, and although the particular arrangement of the present marine boiler may not be the best, it has nevertheless stood the test of a lengthened trial, and to a certain extent can be fully relied on.

To those practically acquainted with the construction of the boilers now in general use in our naval and merchant steam fleets, we shall be understood in describing them as those in which we have first the furnace, then the flame-box as a continuation thereof, then the tubes or flues returning over the furnace to the smoke-box; and, lastly, the uptake leading from the smoke-box to the chimney, and all, excepting the chimney, enclosed in the outer shell. This is the kind of boiler now generally adopted on board ship; in some cases, as in the *Great Eastern*, there are furnaces at each end of the boiler, leading into one flame-box, and having two sets of return tubes, leading to one or two chimneys as may be preferred. This arrangement, well proportioned, can be made the most effective of any, the only drawback being the necessity of having two stoke-holes—a matter of some importance in a small ship.

Adhering to the rule we have hitherto observed to avoid discussing exceptional cases, we will only allude in passing to the existence of two

*From the Lond. Artisan, July, 1859.

other kinds of boiler sometimes placed on board ship. In the one, we have, instead of return tubes, a series of vertical chambers, strongly stayed, and formed of ¼ in. plate. This arrangement has some advantages, one of which is stated to be that of durability. In the other design, introduced into several American mail steamships, the flame passes from the flame-box among a number of vertical tubes to the uptake, the steam being generated from the water in these tubes. We simply mention these exceptional arrangements, because they deserve to be noticed as having been proved by actual experience to be sound and practical.

We now return to the ordinary multitubular marine boiler as previously described, and generating steam generally at a pressure of from 15 to 25 lbs. per sq. in.; 30 lbs. per sq. in. appears to be the limit to which flat surfaces can be safely stayed, without crowding the stays so as to prevent easy access for cleaning and repair, and as also a rectangular form of shell wastes less space in the ship than a cylindrical, the former is almost universally adopted, and will, doubtless, be retained until the use of steam of higher pressure necessitates a different construction better calculated to resist the increased pressure.

The few accidents from explosion that have occurred in British steamships seem to show that as a general rule marine boilers have been constructed of sufficient strength for the pressure used, although this is no proof that the material has been well applied; indeed it is matter of congratulation that we are not at present called upon to criticise the constructive details of a very large portion of our present marine boilers. We must, however deprecate the common practice of attaching long stays intended to resist a strain of 3 tons to one side only of a single angle iron by a badly fitting bolt of 1¼ in. or 1½ in. diameter; as also the system adopted in many large works of plating boilers without reference to the position of the stays, as though they could be shifted any where to suit the seams.

In no branch of mechanical engineering has such a want of science and constructive ability been displayed as in the designing and construction of marine boilers; and at the present time the bulk of our locomotive boilers have the longitudinal joints of the barrels only singly riveted, although it is known that an additional row of rivets would increase the cost but slightly, add some 14 per cent. to the strength of the barrel, and enable the weight to be reduced. It is very questionable if a late explosion and consequent loss of life would have occurred if the system of double riveting had been adopted.

The very best engineering should be displayed in the mechanical design and construction of boilers; and if an ignorant class of men are employed as foremen, the drawings supplied to them should be of the most complete and precise description.

In investigating the working efficiency of the present multitubular marine boilers, we are met at starting by a difficulty not experienced in land boilers—we allude to the use of salt water, which not only causes a considerable waste of fuel, but renders it almost impossible to ascertain with any degree of accuracy the evaporating power of a boiler;

and this element of uncertainty as to the duty realized has exercised a most baneful influence on the improvement of marine boilers in the mass.

Our standard works, too, on the steam-engine have greatly underrated the loss of fuel occasioned by the use of salt water, and constantly discharging into the sea a portion of the heat created by combustion in the furnace. It has been assumed that the loss of fuel referred to may be estimated by calculating the heat required to raise the extra feed supplied (to be afterwards blown into the sea), from its entering temperature to that at which it is discharged from the boiler; but observation and experience prove that both water and *steam* are discharged; and hence there is not merely the loss of sensible heat, as before estimated, but also a considerable loss of that latent heat in the steam, previously generated at a considerable expense of fuel. If this is not so, how is the fact accounted for, that in America, as the result of considerable experience in both fresh and salt water boilers, it is found absolutely necessary to allow at least one-fourth more boiler power when salt water is used than when fresh, whilst many engineers allow even a difference of one-third?

We have then in ordinary practice, instead of a loss of some 10 or 12 per cent., as generally stated, a loss of at least 20 per cent.; and we have known instances where the loss of evaporative power, by changing from fresh to salt water, has amounted to 30 per cent.

If we are moderate, and take one-fifth as the actual loss, this alone is a serious drawback, when economy of fuel is of so much importance on board ship. There is without doubt considerable difference in the amount of loss by blowing out, according as the engineer in charge is more or less intelligent; for whilst on the one hand too much regard to economy may ruin the boiler, on the other, too much regard to avoidance of incrustation will result in needless waste of fuel.

We repeat, that in consequence of the inconvenience attending any attempts to ascertain the actual evaporation or economical efficiency of marine boilers, the most extreme views and practice have obtained, and almost without comment or criticism; no one knows with certainty the actual result of any particular arrangement or proportion, and consequently, no one has the means of giving a standard for comparision.

Among several thousand boilers now in use, we find the greatest variety of constructive proportions, and as a natural result there exists a difference of 30, 40, and 50 per cent. in the evaporative power of boilers having equal heating-surface and fire-grate.

The amount of heating-surface and fire-grate allowed for a given nominal power, varies 25 and 100 per cent. respectively, whilst the ratio between these two main elements varies fully 70 per cent. We are literally "at sea" in marine boiler engineering, nor do we seem to acknowledge practically that, except under special circumstances, there must be certain arrangements and proportions that will give the best result.

The first desideratum in all boilers is to obtain as perfect combustion of the fuel as possible, and experience has fully proved that, unless special arrangements are made for a supply of oxygen to the fuel, in

addition to what is passed through the fire-grate, by a natural draft, and unless ample space is allowed in the furnace and flame-box for the products of combustion to combine, and maintain a high central temperature, the total heat resulting from combustion will be far short of what can be realized.

Now these are not opinions, they are proved facts—obvious to every unprejudiced practical engineer; and it is, therefore, difficult to explain why so many boilers are designed with proportions entirely at variance with these ascertained facts.

Seldom are efficient arrangements made for the required supply of air, and the furnaces are so contracted in height that the fuel almost touches the upper plates; and then, as the half-consumed products of combustion struggle along this comparatively cold-walled chamber, they pass into a flame-box (often only 16 in.) as contracted as the furnace; and when they traverse the small tubes the wasteful operation is completed, and results in a deposit of soot, and a most defective evaporation. This state of things exists in the bulk of our present marine boilers, and is discreditable to the reputation of British engineers.

An impartial consideration of comparative results in burning fuel in a boiler furnace appears to indicate that there should be a minimum height of 2 ft. between the fire-bars and furnace-crown, at the dead-plate, and a minimum length of 2 ft. to 2 ft. 6 in. in the flame-box.

Without presuming to pass judgment on the comparative merits of the various schemes for furnishing an extra supply of air to the furnace, for the purpose of effecting a more perfect combustion, and the consmption of smoke, we cannot but feel it is due to Mr. C. W. Williams to express the opinion, that his simple arrangements deserve the best consideration and confidence of practical engineers.

The vexed question of what description of coal is best for marine boilers is yet undecided, although of late years careful experiments have, to a certain extent, disproved the results arrived at by the Admiralty, and given in their three Reports; and we may add, that the public estimation of the value of the best North Country coal, for steam purposes, is greatly increased; and enough has been done to convince the unbiassed that, with certain arrangements of furnace, external smoke can be almost entirely avoided.

In supplying furnaces with fuel, it is to be regretted that the practice is so common of throwing the fresh charge of fuel to the back of the furnace, instead of keeping the fresh fuel supplied to the front near the dead-plate, and, as combustion increases, pushing it towards the bridge. This latter system of firing, as well as others of a similar character, entails rather more work on the stoker, and hence is seldom adopted.

The arrangements generally introduced for the supply of air to the stoke-hole are of the most imperfect description, the cold air descending being met and obstructed by the hot air ascending, and this arrangement is adopted with the knowledge that the evaporative power of marine boilers is often seriously affected by a deficient supply of air to the stoke-hole.

If fault can be found with the present arrangements and proportions of furnace and flame-box, what shall be said of the varied dimensions of the return tubes? On the Thames we have 2¼, 2¾, and 3 in. tubes from 5 to 6½ ft. long; on the Clyde we have from 3 to 4 in. tubes from 6 ft. to 8 ft. in length, and to estimate rightly the importance of these tubes, it must be remembered that they constitute about three-fourths of the total heating surface. Many a marine boiler has been spoilt by the introduction of badly-proportioned tubes. Then there is the question of what actual evaporative value a long tube has; from the results of some careful experiments it has been ascertained that about one-fifth of the length of the tube next the flame-box was equal in evaporative value to the flame-box itself, but that the remaining four-fifths were not together, equal in evaporative value to the one-fifth next the flame-box, and that the one-fifth next to the smoke-box was of very little use for generating steam.

Now, if these experiments are trustworthy, and we believe they are, they must modify considerably the prevailing opinions on the evaporative value of tube surface; and it may be conceded that practical experience with long small tubes has generally corroborated the conclusions to be drawn from them.

The practical difficulty that arises by the adoption of short tubes, is the necessity of increasing the number to obtain that heating surface which the ship-owner expects to receive from the manufacturing engineer, and which he is not inclined to lessen, although with the improved arrangement it may be more effective.

In considering the question of diameter and length of tubes, there are two points to be noticed: first, the sectional area through the tubes being sufficient to receive and convey the expanded gases from the furnace without retarding the same; and, secondly, reducing the length of tube to a minimum consistent with the heating surface required, and the number of tubes that can be conveniently introduced.

It is not our wish to lay down the law on a subject so full of difficulty, but we can safely indicate in what direction we have erred, and what course should be pursued to remedy those errors.

An imperfect and sluggish combustion is the inevitable result of contraction in the sectional area through the tubes, and a waste of fuel is as inevitable where there is a deficiency of heating surface for a given rate and amount of combustion.

Numerous cases occur in daily practice in which both the above errors are existing, and are simply the result of defective information in the designer.

It is not unusual to find a difference of 25 per cent. in the areas of the chimneys of boilers of the same size and proportions; considering that the heated products of combustion gradually cool and contract as they leave the tubes, and that the frictional surface is reduced from about 13 to 1, there can be no doubt that the sectional area of the funnel should be considerably less than that through the tubes; we find, however, frequent instances, where the chimney is as large, and even larger in sectional area than the tubes.

Then who decides on the height of the chimney? why, frequently even in large establishments the draughtsman who prepares the rigging plans, so as to make it look well with his spars, &c.; thus often a boiler that requires an unusually high chimney has a low one.

We have on a previous occasion referred to the connexion always existing between the generating power of a boiler and the difference of temperatures between the escaping gases and the water to be raised into steam; a strong draft and rapid combustion making an effective but not an economical boiler.

With a chimney of a given height—the draft being dependent upon the temperature of the escaping gases—when there is a large proportion of heating surface, a sharp natural draft and rapid combustion are not attainable.

As long as the rate of combustion is dependent upon heat escaping up the chimney, so long must the loss of that heat be submitted to; and if an artificial blast is substituted, and an attempt is made to absorb all the heat created by the combustion in the furnace, we shall still have this practical difficulty, that when the difference between the temperatures of the flues and water becomes, as it would in this case, very small, either a great increase of time must be given to complete the evaporation, or the ratio between the heating surface and the rate of combustion must be greatly increased.

The advantage to be derived from an artificial blast is the power to increase the rate of combustion *ad libitum*, and thus make a small boiler do the same duty as a large one; and, as a question of weight of boiler, such an arrangement is of great importance.

What are the practical deductions to be made from the preceding remarks?

We think there is sufficient evidence, of a thoroughly practical kind, to prove that attention to those arrangements and proportions we have shadowed forth, will result in a considerably increased duty and economy.

With capacious furnaces and flame-box, an ample supply of air both in the stoke-hole and fuel, tubes *not exceeding* 5 ft. in length, and not less than 3 in. external diameter, a ratio of heating surface to fire-grate of not less than 40 to 1, and a rate of combustion from 16 to 22 lbs. of good steam coal per sq. ft. of fire-grate, with such proportions 11 lbs. of water can be evaporated under atmospheric pressure by 1 lb. of coal.

When we compare such a result with the average duty realized at the present time, we feel we are justified in deprecating the present inefficient state of our marine boiler engineering, with its deficient supply of air, contracted furnaces and flame-box, badly proportioned tubes and chimney, and an evaporative duty of only some 7 to 8 lbs. of water by 1 lb. of coal.

Unless surface condensation is introduced there appears little prospect of any extensive introduction of high-pressure steam into steamships, and we must be content for some time yet with a maximum pressure of 30 lbs. per sq. in.

If surface condensation ever becomes general, we may be quite cer-

tain there will be a considerable increase of the working pressure; but to design a boiler adapted for a steamship and capable of resisting a working pressure of 100 lbs. per sq. in., requires great care and experience: either the cylindrical form must be adopted or flat surfaces must be stayed, like the fire-box of a locomotive boiler; in either case, it is impossible to allow of internal cleaning, so that any failure of the fresh water supply would be fatal to durability.

Although the block-ships and gun-boats fitted with high-pressure machinery, and working with salt water, are so seldom under steam, great inconvenience has resulted from the inability to keep the boilers free from incrustation.

If steam could be generated in small pipes, and their durability ensured, it would be a perfect high-pressure boiler, as 200 lbs. per sq. in. could be generated with as much safety as 20 lbs. in our present marine boilers.

We do not think there is any more hopeful branch of engineering than that connected with the propulsion of ships, nor any more likely to repay the improver. Necessity will ultimately oblige both steamship owners and engineers to economize fuel, and a truly satisfactory result can only be arrived at by the most laborious and persevering attention to the minutest details.

Connected with boiler engineering, the profession is much indebted to Mr. Fairbairn for data of a most valuable character; and there are many engineers of the present day who are helping to introduce great improvements. Our English exclusiveness militates greatly against a free interchange of practical experience among our leading engineers, and the young engineer must trust entirely to his own struggles for a position.

In the preceding remarks many points of interest in steam genera-tion have been omitted, but with the excepting ordinary details, they will be referred to in the introductory observations on the Application of Steam as a Motive Power.

(To be Continued.)

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*On Experiments to Determine the Efficiency of Continuous and Self-acting Brakes for Railroad Trains.**

By William Fairbairn, C.E., F.R.S., &c.

[A paper read before the British Association, 1859.]

Of late years various improvements have been introduced upon railways, to diminish the dangers of traveling, and attention is now specially directed to the increase of the retarding power for trains by various kinds of brakes. From an early period in the history of railways, it was seen that few objects were more important for ensuring the security of passengers, and reducing the loss of time occasioned by stoppages, than the attainment of some means of destroying the momentum of trains with ease and rapidity: that is, in the least time and

* From the Lond. Mechanics' Magazine, October, 1859.

in the shortest distance. The less the time requisite to brake a train, the longer the steam may be kept on in approaching a station and the less is the loss of time in stopping. And the shorter the distance in which a train can be brought to a stand, the less danger is there of collision with obstructions on the line perceived not far off ahead. It is already allowed by many of those connected with railways, and has been expressly stated by the Lords of the Committee of Privy Council for Trade, that the amount of brake power habitually supplied to trains is in most cases insufficient, and their Lordships enumerate thirteen accidents from collision occurring in 1858, the character of which they consider would have been materially modified, if not altogether prevented, by an increased retarding power under the command of the guards of the trains.

Upon this subject the most important communication hitherto made has been the Report prepared by Colonel Yolland for the Railway Department of the Board of Trade, and containing a large number of experiments with heavy trains at high velocities. The brakes with which Colonel Yolland experimented were those which, as improvements on the common hand brake, have hitherto commanded most success. These were the steam brake of Mr. McConnel, the continuous brake of Mr. Fay, the continuous and self-acting brake of Mr. Newall, and the self-acting buffer brake of M. Guerin. The general conclusions to which Colonel Yolland was led by his experiments resulted in the recommendation of the brake of Mr. Newall; and for heavy traffic, a provisional recommendation of the brake of M. Guerin.

From a misunderstanding caused by this Report of Colonel Yolland arose the necessity for some further experiments on the similar brakes of Mr. Fay and Mr. Newall; and these I was called upon to arrange and carry out, by the directors of the Lancashire and Yorkshire Railway. I propose to lay before the Association a brief abstract of these experiments, with some remarks upon the conclusions to which they gave rise.

It will not be necessary here to describe minutely the details of the construction of these brakes. They consist essentially of a series of brake blocks acting upon every wheel of the carriages of the whole train or some part of the train, the brake blocks being suspended as flaps or placed on side bars beneath each carriage, as in the ordinary arrangement of the guard vans. But whereas it would be both expensive and inefficient to work these brakes with a guard or brakesman to each carriage, both Mr. Fay's and Mr. Newall's patents provide for a continuous shaft, carried the whole length of the train beneath the framing, and with suitable jointed couplings between each pair of carriages, so that they may be undisturbed by the rocking motion of the train or the action of the buffers. In this way the whole of the brakes may be worked by a single person at either end of the train communicating his power to each brake through the agency of the continuous shaft.

Again, there have been applied, in the first instance by Mr. Newall and subsequently by Mr. Fay, powerful springs beneath each carriage, connected with the arms of the rocking shaft, by means of which the

brakes are made to act instantaneously throughout the train, on the release of a catch or disengaging coupling in the guard's van. The value of this provision for the immediate and simultaneous action of the whole of the brakes, in cases where an obstruction is perceived upon the line, will be at once evident. It is one of the most important features of these brakes.

In carrying out the views of the directors of the Lancashire and Yorkshire Railway Company, it was arranged, in order to test the relative efficiency of these brakes, to have a series of experiments upon the Oldham incline of 1 in 27 on this gradient. A train of carriages fitted with Mr. Newall's self-acting slide brakes, and a similar train fitted with Mr. Fay's continuous flap brakes, were started in turn, and after having passed over a measured distance by the action of their own gravity, the brakes were applied, and the distance along the incline in which the trains were respectively brought up was carefully ascertained, as a measure of the retarding force of each. The trains employed consisted of three weighted carriages each, and having been placed upon the incline, they were started by removing a stop. Having then descended a previously measured distance with a uniformly accelerating velocity, they passed over a detonating signal, which conveyed notice to the guard to put on the brakes. Then the train having been brought to a stand, the distance from the fog signal to the point at which the train stopped was measured, and the train brought back for another experiment. In this way it was easy to obtain an initial velocity of 50 ft. a second, or 35 miles, before applying the brakes.

Unfortunately, the day upon which these experiments were made proved misty and foggy, with rain at intervals, so that the rails were in the very worst condition for facilitating the stoppage of the train. The significance of this fact will be seen on comparing the retarding power of the brakes in these experiments with those made in fine weather.

Reducing the results, we find that the retarding force exerted by each brake in terms of a unit of mass, was equivalent to the numbers in the following table:—

EXPERIMENTS ON THE OLDHAM INCLINE.

No. of experiment.	Mr. Newall.			Mr. Fay.		
	Velocity of train in feet per second.	Time in stopping in seconds.	Retarding force of brake.	Velocity of train in ft. per second.	Time in stopping in seconds.	Retarding force of brake.
1	25·71	14	1·32	25·71	13	1·91
2	30·00	16	1·63	30·00	13	1·79
3	37·50	17	1·70	37·50	14	1·84
4	42·85	25	1·69	41·37	15	1·76
5	42·85	14	2·01	40·66	12	2·02
6	48·38	19	1·78	48·38	25	1·72
7	52·94	17	2·04	50·00	17	1·91
	Mean.	21·6	1·74	Mean.	19·2	1·85

The general result of these experiments gives a retarding force of 1·74 lbs. per unit of mass for Mr. Newall's brake, and 1·85 for Mr.

Fay's. Or, in other words, Mr. Newall's brake exerted a retarding force of 121·3 lbs. per ton weight of the train, and Mr. Fay's a retarding force of 129 lbs. per ton.

I afterwards arranged for some further experiments at Southport upon a piece of level rail between that town and Liverpool. The speed requisite in this case had to be obtained by the aid of an engine, which was detached by a slip coupling at the instant of applying the brakes. In other respects these experiments were conducted like the preceding, with fog-signals, and the time noted by stop watches. The weather, however, was in this case fine and dry, and hence the following results were obtained in the most uniform circumstances.

The friction of the train itself, and the resistance of the air, was ascertained to amount with Mr. Newall's train to 6·4 lbs. per ton, and with Mr. Fay's train to 10·4 lbs. per ton.

EXPERIMENTS AT SOUTHPORT.

Slide brakes; Engine detached.

Mr. Newall.			Mr. Fay.		
Speed in miles per hour.	Distance of pulling up in yards.	Retarding force of brake.	Speed in miles per hour.	Distance of pulling up in yards.	Retarding force of brake.
32·72	56⅔	6·77	35·29	56	7·97
36·73	77	6·28	43·90	98	7·05
43·90	136	5·08	50·00	129	6·94
46·15	140⅔	5·42	54·54	144	7·40
52·94	205⅓	4·89	54·54	161⅔	6·59
54·54	192	4·66	37·89	97	5·30
47·37	260⅓		60·00	204⅔	6·30
53·73	222	5·23	60·00	214	6·03
63·16	273	5·55			
Mean.		5·49	Mean.		6·70

In this case we have a retarding force per unit of mass equivalent to 5·49 lbs. in Mr. Newall's brake and 6·7 lbs. in Mr. Fay's. Or, in other words, the retarding force of the slide brakes of Mr. Newall, from eight experiments, at velocities varying from 35 to 60 miles an hour, was equivalent to 382·6 lbs. per ton weight of the train. The retarding force of Mr. Fay's slide brake, from eight similar experiments, at velocities from 33 to 63 miles per hour, was equivalent to 466·4 lbs. per ton weight of the train.

FLAP BRAKES—ENGINE DETACHED.

Mr. Newall.			Mr. Fay.		
Speed in miles per hour.	Distance of pulling up in yards.	Retarding force of brake.	Speed in miles per hour.	Distance of pulling up in yards.	Retarding force of brake.
50·00	132⅔	6·75	51·43	158⅓	5·98
50 00	123	7·28	51·43	162⅔	5·82
51·43	192	4·93	54·54	184	5·79
Mean,		6·32	Mean,		5·87

These experiments give for the retarding force of Mr. Newall's flap brake 6·32 lbs. per unit of mass, and for Mr. Fay's, 5·87 lbs.

Or, in other words, the retarding force of Mr. Newall's flap brake, from three experiments at velocities varying from 50 to 51½ miles per hour, was equivalent to 440·3 lbs. per ton weight of the train.

The retarding force of Mr. Fay's flap brakes, from three similar experiments, was 408·6 lbs. per ton.

We may illustrate the general bearing of these experiments by estimating from an average of the whole experiments the distance required to stop a train fitted with these brakes, and detached from the engine:—A train would be stopped at a velocity of

20 miles an hour in . . .	23·4 yards.
30 " "	52·9 "
40 " " . . .	93·8 "
50 " " . . .	146·8 "
60 " " . . .	211·5 "

This last table exhibits, in a very clear manner, the advantages of this class of brakes, in which the whole weight of the train aids in destroying the momentum of the mass instead of the weight of one or two guard vans only. It may be impossible in long trains to apply these brakes to every carriage; but at all events, in the ordinary traffic, three times the present amount of brake power may be employed with ease.

On the score of economy, also, the system appears to encourage its application. From experiments which have been made, it appears that the wear of the tyres is far more uniform and equal, because the springs may be so adjusted as not to cause the wheels to skid. The manager of the East Lancashire Railway states that with two trains running together between Salford and Colne, the carriages fitted with continuous brakes traveled 47,604 miles before the wheels required turning up; whilst an ordinary brake van, running the same distance, had to have its wheels turned up three times in the same period, three-eighths of an inch being taken off each time.

EXPERIMENTS AT SOUTHPORT.

Engine not detached from the trains.

Mr. Newall.		Mr. Fay.		Remarks.
Speed per hour.	Distance of pulling up.	Speed per hour.	Distance of pulling up.	
Miles.	Yards.	Miles.	Yards.	
33·96	124⅔	31·8	121⅔	
37·11	169⅓	33·96	137	Engine and tender.
41·86	221	41·86	192⅓	Tender brake applied.
		51·43	274	Tank engine.

It will be observed that on most through lines the trains travel on some portion of the distance at the rate of 60 miles an hour; and in the event of an obstruction half-a-mile in advance a collision would be inevitable unless the driver has the power and the presence of mind to act with promptitude. Now, at 60 miles an hour there is only 30 seconds, or half-a-minute, to effect that object, and it is quite impos-

sible to apply the brakes in their present state before the train—in such a precarious position—is in actual contact. Assuming, however, that brakes upon the principle of Newall and Fay were attached to the engine as well as the train, and that the driver had the power of instantaneous application, by liberating a spring, it is evident that instead of the train dashing forward to destruction, the momentum might be destroyed in a distance of less than 500 yards, and that without injury to life or property. Besides, the application of the electric telegraph, which prevents on most through lines more than one train being on the line between the stations, is a great additional security, and that united to the continuous brake *applied to the engine as well as the train* would, when united to a more perfect system of signals, render collision next to impossible.

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*Experimental Researches to Determine the Density of Steam at all Temperatures.** By W. Fairbairn, F.R.S., & T. Tate, F.R.A.S.

[Proceedings of the British Association, 1859.]

I propose to give a short sketch of an apparatus, and the results of the earlier experiments which, in conjunction with my friend Mr. Thomas Tate, I have been investigating by direct experiments, with the intention of determining the law of the density of steam and other condensible vapors; and thus to solve a hitherto almost untouched problem by an experimental method, which will verify or correct the theoretical speculations in regard to the relation between the specific volume and temperature of steam and other vapors. The experiments are being conducted, it is believed, upon an entirely novel and original principle, and one which is applicable at any temperature and pressure capable of being sustained by glass vessels.

For a perfect gas, the law which regulates the relation between temperature and volume is known as Gay-Lussac's or Dalton's law, and is expressed by the equation:—

$$\frac{V \times P}{V_1 \times P_1} = \frac{458 + t_1}{458 + t} \quad . \quad . \quad (1).$$

Now, density of steam has been determined with accuracy by direct experiment at the temperature of 212°—and at that temperature only by the method of Dumas. At 212° Fahrenheit its density is such that its volume is 1670 times that of the water which produced it.—Hence, assuming Dalton's law to hold for steam, and substituting these values of volume, temperature, and pressure, we get for the volume of steam from a unit of water at any other temperature:—

$$V = \frac{1670 \times 15}{670} \times \frac{458 + t}{P}, \text{ Or, } V = 36\tfrac{1}{3}\frac{458 + t}{P}, \qquad (2).$$

These are the well-known and received formulæ from which all the tables of the density of steam have hitherto been deduced, and on which calculations on the duty of the steam-engines have been founded. Up to the present time, however, this formula has never been verified by

* From the Lond. Mechanics' Magazine, Oct, 1859.

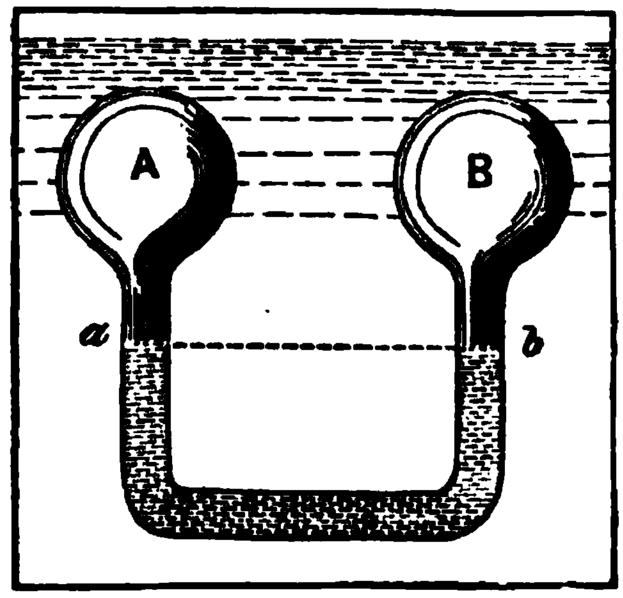
direct experiment, nor are the methods hitherto employed in determining the density of gases and vapors applicable in this case, except at the boiling temperature of the liquid at the ordinary atmospheric pressure. But, on the other hand, theoretical speculations throw considerable doubt on the accuracy of the above formula when applied to steam and other condensible vapors. Several years ago, Dr. Joule and Professor William Thomson announced, as the result of applying the new dynamical theory of heat to the law of Carnot, that for temperatures above 212° Fahrenheit, there is a very considerable deviation from the gaseous laws in the case of steam. Later, in 1855, Professor Macquorn Rankine has given a new theoretical formula for the density of steam, independent of Gay-Lussac's law, and confirmatory of Professor Thomson's surmise. But as yet these speculations need the evidence and verification of direct experiment.

The density of steam is ascertained by vaporizing a known weight of water in a glass globe of known capacity, and noting the exact temperature at which the whole of the water becomes converted into steam. From these three elements,—volume, weight, and temperature—the specific gravity is known. But in pursuing this method, these two difficulties must be overcome. First, the pressure of the steam renders it necessary that the glass globe should be heated in a strong and consequently opaque vessel. Second, as steam rapidly expands in volume for any increase of temperature beyond the temperature of saturation, it would, in any case, be impossible to decide by the eye the temperature at which the whole of the water became vaporized. The temperature of saturation, or temperature at which the whole of the moisture is converted into steam, whilst no part of the steam is superheated, must be determined with the utmost accuracy, or the results are of no value.

The difficulties thus resolve themselves into finding some other test of sufficient accuracy and delicacy to determine the point of saturation. This has been overcome by what may be termed the saturation gauge; and it is in this that the novelty of the present experiments consists.

To illustrate the principles of the saturation gauge, suppose two globes A and B, Fig. 1 connected by a bent tube containing mercury at *a b*, and placed in a bath in which they can be raised to any required temperature. Suppose a Torricellian vacuum to have been created in each globe, and twenty grains of water to have been added to *a*, and thirty or forty grains to B. Now, suppose temperature to be slowly and uniformly raised around these globes; the water in each will go on evaporating at each temperature, being filled with steam of a density corresponding to that temperature, and the density being greater as the temperature increases.—At last a point will be reached at which the whole of the water in globe *a* will be converted into steam, and

Fig. 1.



at this point the mercury column will rise at *a* and sink at *b*; this is the saturation test, and the cause of its action will be easily seen. So long as vaporization went on in both A and B, and the temperature was maintained uniform, each globe would contain steam of the same pressure, and the columns of mercury, *a* and *b*, would remain at the same level. But so soon as the water in *a* had vaporized, and the steam began to superheat, the pressure in *a* would cease to remain uniform with the pressure in B, and the mercury column would at once fall, and thus indicate the difference. The instantaneous change of the position of the mercury is the indication of the point at which the temperature in the bath corresponds with the saturation point of the steam in *a*.

To show the delicacy of this test, I may instance that at 290° Fahrenheit, the mercury column would rise nearly two inches for every degree of temperature above the saturation point, as the increase of pressure arising from vaporization is twelve times that arising from expansion in superheating at that point, and a similar difference exists at other temperatures.

Fig. 2.

The apparatus as employed for experiment, varies according to the pressure and other circumstances of its use. Fig. 2 represents one of the arrangements which has been employed with success. It consists of a glass globe of about seventy cubic inches capacity, in which is placed, after a Torricellian vacuum has been formed, the weighed globule of water. The globe with the stem is shown at A; this is surrounded by a copper boiler B B, prolonged by a stout glass tube C C, enclosing the globe stem. This copper boiler forms the water and steam bath through which the globe is heated, and in fact corresponds to the second globe B, in the former figure. The fluctuating mercury column, or saturation gauge, is placed at the bottom of the tube C C, and the saturation point is indicated by the rise of the inner mercury column *a*, and the fall at the same time of the outer mercury column *b*. As soon as the whole of the water in the globe A is evaporated, there is an instantaneous rise of the inner mercury column to restore the balance of pressure, and that progressively with the rise of temperature.

As an auxiliary apparatus the boiler is provided with gas-jets, E, to heat it, and with an open oil-bath G to retain the glass tubes at the same temperature as the boiler, and this oil-bath is placed on a sand-bath, and also heated with gas. A ther-

mometer D registers the temperature, and a pressure gauge F the pressure of the steam; and a blow-off cock H serves to reduce the temperature when necessary. A number of results have already been obtained, but they are not yet sufficiently advanced to be made public. The following numbers have been, however, approximately reduced from the theoretical formula above, and the experimental results may illustrate the use of this method of research. The most convenient way of expressing the density of steam is by stating the number of volumes into which the water of which it is composed has expanded. Thus one cubic inch of water expands into 1670 cubic inches of steam at 212° Fah., into 882 cubic inches at 251°, and into 400 cubic inches at 304°, and so on; in this way the following numbers have been computed:

	Volume of Steam.	
Temperature	By Formula.	By Experiment.
244°	1,005	896
245°	969	890
257°	790	651
262°	740	690
268°	680	633
270°	660	604
283°	540	490

These determinations at pressures varying from ten to fifty lbs. above the atmosphere, are not accurate reductions from the experimental results, but only approximations. But they uniformly show a decided deviation from the law for perfect gases, and in the direction anticipated by Professor Thomson, the density being uniformly greater than that indicated by the formula. I hope by the time of the next meeting of the Association, with the assistance of my friend Mr. Tate, to be enabled to lay before the section a series of results which will fully determine the value of superheated steam, and its density and volume as compared with pressure at all pressures, varying from that of the atmosphere to 500 lbs on the square inch.

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*The Accident at the Polytechnic Institution.**

In one of the various actions against the directors which have been brought by persons injured by the falling of the stairs at the Polytechnic, the Lord Chief Baron of the Court of Exchequer, in addressing the jury, said that, from the evidence of Mr. Nelson, the accident occurred from an original defect in the stone, not visible on the surface, and which no one could detect. It would be their duty to return a verdict for the defendants, and he hoped the directors would not be harassed with other actions of a similar kind. Verdict for the defendants.

*From the London Builder, No. 855.

AMERICAN PATENTS.

List of American Patents which issued from October 4, to October 25, 1859, (inclusive,) with Exemplifications.

OCTOBER 4.

1. **Stoves**; James G. Abbott and Archilus Lawrence, Philadelphia, Pennsylvania.

Claim—The combination of the ring, perforated door frame, extending down over the ring and slide, with the stove cylinder.

2. **Corn Planters**; J. C. Adams, Greensburg, Indiana.

Claim—The arrangement of the clevis device on the rear of the pole, when said pole is received through the mortise in the bar, and when the said bar is made adjustable, by means of bolts and bolt holes, through its ends and through the frame pieces, said clevis device being made so as to clasp together cross-pieces.

3. **Apparatus for Evaporation**; Charles Alden, City of New York.

Claim—The agitator, so constructed as to be capable of acting as a blower as well as a stirrer.

4. **Steam Gauge**; Albert J. Allen, Buffalo, New York.

Claim—1st, Capsule, *a*, of peculiar construction, having the steam admitted at one side and through the centre of that side, and using the flexibility of both sides (such capsule being made of a permanently elastic metal, and not injuriously oxidized by steam or water, preferring for that purpose the metal used in making melodeon reeds), in combination with fulcrum block, lever, spring, rod, *o*, rod, *i*, swivel block, radius bar, and segment, having tail-pin, pinion, index-pointer, dial plate, and friction pressure spring. 2d, Radius bar, in combination with rod, *i*, swivel block, segment, having tail-pin, pinion, index pointer, and dial plate, having increasing divisions on its face. 3d, Swivel block, in combination with rod, *i*, radius bar, and segment, having tail-pin.

5. **Seed Planters**; John P. Allen, Midville, Georgia.

Claim—The arrangement and combination of the frame provided with the armed hub, the hopper, and its bar, in connexion with the adjustable bar provided with the self-adjusting covering plate or bar.

6. **Feed-water Apparatus for Steam Boilers**; Thomas Armitage, Philadelphia, Pennsylvania.

Claim—The vessel, with its valve opening inwards, in combination with the pipes, with their respective cocks, and the drum arranged in respect to the boiler, as set forth.

7. **Mole Plough**; Henry F. Baker, Centreville, Indiana.

Claim—The arrangement and combination of the screw, key, knife, share, and revolving packer, as described. Also, the employment of a revolving mole or packer, as described.

[This improvement consists in attaching to the back part of the circular share a revolving, spirally-fluted frustrum of a cone, the share being fastened to the lower end of a cutting knife, and the furrow being pressed down by a following roller.]

8. **Weeding-hoes**; H. H. Baker, New Market, New Jersey.

Claim—The arrangement of the piece, standard, plate, concave, and ferrule, as described.

9. **Rotary Harrows**; O. D. Barrett, Cleveland, Ohio.

Claim—The arrangement of the hooks, draft bars, centre-pins, arms, and spring joint, as set forth.

10. **Construction of Vapor Burners**; Wm. W. Batchelder, City of New York.

Claim—Arranging the orifice of discharge from the retort, in reference to the open end of the gas pipe, so that the sediment from the orifice cannot fall into said pipe nor remain about and choke the orifice. Also, the entire disconnexion of the pipe and retort. Also, the combination of the circular form of the gas pipe with the horizontal discharge. Also, connecting the retort with the ascending part of the gas pipe near the burner.

11. **Machine for Cutting Veneers**; Mahlon Bonnell, City of New York, and Isaac J. Cole, Tappan, N. J.

Claim—1st, The arrangement of the cams, or their equivalents, in combination with the log-carrier. 2d, The arrangement and combination of the log-carrier with the tank, or its equivalent.

[A rotary log-carrier is employed, to the surface of which the logs are secured, so as to strike against a stationary cutter. As the logs rotate with the cutter they are dipped into hot water contained in a tank under the log-carrier, and the cutting operation is further facilitated by giving to the log-carrier a side motion, whereby a shear cut is produced and much power saved.]

12. **Construction of Evaporating Apparatus**; Nathaniel Bourne, Peosta, Iowa.

Claim—The arrangement and combination with the evaporating pan of a series of partitions and shutters, as described.

13. **Apparatus for Laying Drain Tile**; B. B. Briggs, Sharon, Ohio.

Claim—The described clutches, consisting of the block or body and the fingers, in combination with the rope, or its equivalent, and hook, arranged as specified.

14. **Knapsacks**; Robert C. Buchanan, United States Army.

Claim—The combination of the body yoke and end pockets to the knapsack, combined as set forth.

15. **Brick Moulds**; J. A. Buckwater, Kimberton, Pennsylvania.

Claim—The expanding frame formed of the movable plates and fitted within the frame, provided with the inclined or taper pendants and inclined slats, the plates being connected respectively to the pendants and slats by the pins and staples.

16. **Measuring Faucet**; Erastus Toucy Bussell, Covington, Kentucky.

Claim—Operating the cut-off by a rotary movement of the exhaust chamber, which comprises the measure proper, whereby the fluid is first admitted into said measure and then discharged therefrom. Also, a graduated plunger-rod, square or otherwise, so as to admit of stop notches on each side, independent of the others, into which a pin is forced by a spring.

17. SUPPORTING THE CARRIAGE BODIES OF FIRE ENGINES; Lysander Button and Robert Blake, Waterford, New York.

Claim—The propping of fire engines, which are mounted upon springs by means of cams, or mechanical equivalent thereof, so arranged and operated as, by lever power, to throw the weight of the engine from and upon the springs.

18. FIRE-PLACES; G. A. Clark, Farmington, Connecticut.

Claim—The described arrangement of caliducts, when the same are applied to a fire-place, in the manner set forth.

19. COTTON GINS; Powhattan Ellis Collins, Mobile, Alabama.

Claim—An adjustable hopper for changing and regulating the feed of cotton to a gin. Also, in combination with an adjustable and regulating hopper, the toothed cylinder for conveying the cotton from the hopper to the ginning or saw cylinder. Also, the arrangement of the hopper, feeding toothed roller, saw and brush cylinders, so as to operate in connexion with each other.

20. TRAY BOLT; Garrett Cooper, Jersey City, New Jersey.

Claim—The general arrangement of bolt, shield, ripple, and plate of metal, when said bolt shall effect its own spring, arranged in the manner described.

21. MANNER OF HANGING RECIPROCATING SAWS; Pearson Crosby, City of New York.

Claim—Connecting the two plates of the caps by means of rivets and pins, the ends of which are fitted in holes counter-sunk at the inner sides of the plates to admit of the vertical adjustment of the plates. Also, encompassing the rivets of the cap by tubes or cases to form a bearing for the plates, and prevent an undue pressure of the caps against the saw, so that the latter may be adjusted to compensate for wear—it being understood that I do not claim, broadly, the tubes or cases, but only when used in connexion with, or applied to, the caps.

22. BREAD AND VEGETABLE SLICER; Joshua and Sarah N. Davis, Muskegon, Michigan.

Claim—The arrangement and combination of the adjustable slotted plates, gauge, rod, spring, and lever, so that the slice of bread shall be supported by the gauge until the stroke of the knife is almost finished, and so that the gauge shall fall outwardly on the depression of spring.

23. BLIND FASTENER; William H. Davis, Taunton, Massachusetts.

Claim—The application to the catch, of a box, to secure it from getting out of place, and of the hook on the blind a rest to prevent the blind from sagging.

24. ACCOUNTANT LABELS FOR PERIODICALS, &c.; Robert Dick, Toronto, Canada; patented in Canada, July 6, 1858.

Claim—The contrivance of keeping accounts in printed form by the use of printer's type, or their equivalents, kept so arranged as to admit readily of all the re-adjustments which the currents of business may require, in manner set forth. Based on this primary invention, I also claim the device of rendering or transmitting accounts thus, or substantially thus kept in type, by sending printed impressions taken therefrom, though the particular form of sending may not be mine. While at the same time I claim, in the broadest and fullest, the special mode and form set forth by use of the machine described, as constituted by the combination of fluid vessel, reel, apron movement, and cutter stamp, which machine I also claim, with all the modes indicated for operating the same, and in connexion with the recited claims I thus formally make. Also, all other means and appliances, substantially the same as those claimed or intended to be claimed.

25. BORER FOR EXCAVATING MUD, &c.; Mason H. Ford, City of New York.

Claim—1st, The construction of revolving excavating scoops, provided either with openings and wings or flanches on its sides, capable of opening and shutting, or so constructed that part of the sides may be opened, and act in that position as wings or flanches, by which the dirt, mud, or sand is, during the revolving of the scoop, thrown into the inside of the scoop. 2d, The manner of attaching scoops to the shafts, so that the same will be made to turn with the shaft when the same is revolving, and at the same time capable of being raised above the surface of the water, when filled, for the purpose of being emptied, without requiring to raise the shaft.

26. COOKING STOVES; Peter Getz, Lancaster, Pennsylvania.

Claim—The specific arrangement of the boilers, drum-head oven, and their combination in manner as set forth.

27. WEIGHING SCALES; William D. Guseman, Morgantown, Virginia.

Claim—The triangular recess cut out on the under side of the journals of the pendulum drum or shaft, to enable said drum to swing or roll on its axis on the upward pointing-knife edges. Also, in combination with an upward pointing-knife edge, a roller or pendulum drum, the journals of which are formed with triangular recesses and a counterpoise weight, or its equivalent, vibrating below the centre of the drum or roller, and this I claim whether the counterpoise be adjustable on its lever or not.

28. STAVE MACHINE; Henry Hays, City of New York.

Claim—Dressing staves by a continuous operation, regardless of length or thickness, by the combined action of the feed rollers and cutters, when said parts are arranged to remove a shaving from the outer side of the stave, under all circumstances, and split out more or less from the inner side to reduce the stave to a uniform thickness.

29. STEAM BOILER; Joseph Harrison, Jr., Philadelphia, Pennsylvania.

Claim—The construction of a boiler of distinct globular or spherical parts, single or in groups, united in the manner specified, or any other analogous thereto, and wherein the strength of the globular form of such parts is common to the entire structure: this claim being intended to include not true spheres only, but elliptical, conical, polyhedral, or any other analogous forms also, where the results looking to strength and construction of the boiler, are substantially the same as those enumerated. Also, the employment, as units of construction, as hereinbefore explained, of separate chambers of cast iron or other metal, of uniform size and shape, substantially as described, to be used as wanted, wherewith boilers of different forms and dimensions may be built up, being united together in the manner specified, or any other analogous thereto. Both of the above claims involve an outside casing for the particular construction, with furnaces, substantially as described. It is not, however, my intention to confine myself to any special form of boiler or mode of casing the same.

30. DEVICE FOR CONNECTING THE PANELS OF PORTABLE FIELD FENCES; Joel Haines, West Middleburg, Ohio.

Claim—The jointed link for connecting the ends of the panels, so arranged that by using a tapering key

in the link, the angle of a zigzag fence may be made more or less obtuse, as required, to make the fence stand firm in the position in which it is placed.

31. PUMPS; W. M. Henderson, Baltimore, Maryland.

Claim—The two ball valve cages, with the suction valves in the interior, attached to the extremity of a central perforated tube, or its equivalent, in combination with the water-ways and discharge valve, constructed in the manner set forth.

32. FAUCETS; Thompson Hersee and Pierre Jos. Bourgnon, Buffalo, New York.

Claim—1st, The relative arrangement of the valve, chamber and spherical, part, in combination with the plug, said valve having a lifter and stem, operating as described. 2d, The combination and arrangement of the lifting rod, valve, tube, and pipe, with the cross-piece, for the purpose of ventilating the barrel at each draft.

33. CURTAIN FIXTURE; John B. Holmes, Jr., City of New York.

Claim—The spring, in combination with the roughened, V-shaped, grooved pulley, an endless cord or band, arranged as specified. Also, the brackets. c c', provided with the centre-pins entering the roller ends, in the manner specified. Also, forming the bracket, c, with the slot and open ring, and the bracket, c', with a hook-shaped slot to afford opportunity of removing the whole of the parts without having to draw the screws or nails passing through said brackets.

34. SIGNAL LANTERNS; Lewis Hover, Flushing, New York.

Claim—The arrangement and combination with the case and lamp, of the metallic cylinder and glass cylinder, as described.

35. TOOL FOR CUTTING GAS PIPE; Job F. Howland, City of New York.

Claim—The arrangement of a stationary iron frame with a slot in it, which terminates in a conical form at one end, in combination with a sliding jaw having a V-shaped tongue, and with an adjustable sliding cutter.

36. MODE OF DISINFECTING FEATHERS; J. W. Howlet, Greensboro', North Carolina.

Claim—The injection of combined steam and chlorine gas among the feathers, as described.

37. VEGETABLE CUTTER; B. C. Hoyt, Port Washington, Wisconsin.

Claim—The arrangement of the cutting-box upon a vibrating lever, when the lever is supported by a spring, actuating arm, for keeping the whole in an elevated position. Also, the combination of slide, angular slotted box, and vertical cutters, arranged in the manner set forth.

38. MOLE PLOUGHS; Rameth Hussey and Uriah Thornburgh, Sr., Walnut Run, Ohio.

Claim—Suspending the plough-beam that carries the mole to the plough-frame by means of ropes or chains, connecting its ends to one capstan, in combination with suitable catches for holding it at any adjusted height thereon. Also, in combination with the rotary mode, suspending the plough-beam by both its ends to ropes or chains which connect with a common capstan on the plough-frame, in combination with racks and pawls for holding said beam when adjusted.

39. SPARK-ARRESTERS; I. E. Jones, Cincinnati, Ohio.

Claim—The arrangement of the tank, wind-wheel, and agitator, with reference to the receiving trunk and valve.

40. ROTARY HARROWS; M. C. Kilgore, Washington, Iowa.

Claim—The arrangement and combination of the windlass, arms, socket, collar, harrow, and spindle, as described.

[This invention consists in suspending from a pivoted collar, fixed centrally to a shaft mounted upon wheels, a rotary harrow supported or swung by chains or cords which pass round a windlass, so that the harrow will be rigidly attached to the frame or axle of the machine, at the same time it can be raised or depressed, or inclined to the surface of the ground.]

41. ATTACHMENT TO TREADLES OF SEWING MACHINES; H. B. Knowles, Providence, Rhode Island.

Claim—The employment of a yielding adjustable rod, having a cross-head with hooks at its upper end, in combination with a shackle-bar, crank-shaft, and treadle, as set forth.

[The object of this invention is to prevent the crank of a sewing machine, or of any other machine which may be operated by a treadle, from slipping on to the dead point, and to connect the treadle to the crank in such a manner that the machine can always be started with the foot in the right direction, while it is impossible to turn it in the wrong direction, except by force or by the aid of the hands. A spring is connected to the shackle-bar in such a manner that it begins to act on the same as the crank approaches the dead points. When the machine is turned in the right direction, the spring pushes the crank beyond the dead points; but if an attempt is made to turn the crank in the wrong direction, said spring opposes its passing the dead points.]

42. PUNCHING METALS; Philip Koch, New Haven, Connecticut.

Claim—1st, The employment or use of a series of arbors to which punches or shear blades are attached, fitted in a rotating or adjustable head, when said head is connected with an arbor having a plate attached, provided with bolsters and shear blades, corresponding with the punches and shear blades of the head. 2d, The means employed for actuating the yoke and consequently the arbors, to wit: the adjustable shaft, K, provided with the eccentric, J, pin, w, fitted within the block of yoke, the adjustable shaft, P, provided with the lower crank and the recess in the back part of plate to receive pin, w.

43. PLOUGHS; E. D. Lee and Z. W. Lee, Blakely, Georgia.

Claim—The arrangement of the peculiar curved clevis, beam, curved rod, bar, band, wedge, shank, projection, and share, as specified.

44. SAFETY APPARATUS FOR STEAM BOILERS; L. E. Lincoln, Lowell, Massachusetts.

Claim—The application of a low water alarm to more than one boiler (or to one), by means of a two or more legged tube, a simple or a compound siphon, in such manner that said tube shall keep said alarm charged with water, when all its pendant ends are covered by water, and shall cause said alarm to be supplied with steam, when any one of its pendant ends is exposed to steam.

45. MANGLE; W. T. Littlejohn, Kalamazoo, Michigan.

Claim—The arrangement of the levers with roller at their upper end, the spring, bar, connected to the treadle by the rope, in combination with stationary roller.

46. MUSICAL NOTATION FOR THE BLIND; Cornelius Mahoney, City of New York.

Claim—The combination of letters and characters, or notes, in embossed print, so as to represent music for the blind.

47. **Valves for Retarding and Arresting the Flow of Gases**; Newton S. Manross, Bristol, Connecticut.

Claim—The use of a re-curved or V-shaped tube or passage, having its lower part connected with a well or reservoir, containing quicksilver, which is made to rise within the tube by means of a plug, or other equivalent pressure. Also, the combination of such re-curved tube, closed by quicksilver, with the regulating apparatus, consisting of a tapering shoulder and movable rod, secured from leakage by passing through the quicksilver.

48. **Coffins**; H. Marshall, Cincinnati, Ohio.

Claim—A coffin having its bottom ends and sides wholly constructed of corrugated sheet metal, which is rolled or stamped into proper form, and surrounded at the upper edge of its body with a wrought or cast iron frame, which serves as a brace to the body and a hold-fast for screws.

49. **Hydrants**; N. B. Marsh, Cincinnati, Ohio.

Claim—The arrangement, in connexion with the main casing, discharge pipe, and air chamber, of a hydrant of the upper and lower plunger or valve chamber, made in one piece, upper plunger or valve, when composed of parts, k l m n r, and lower conical guide and stop-plunger, composed of parts, s h i, in the manner described.

50. **Breech-loading Fire Arms**; J. Plympton Marshall, Millbury, Massachusetts.

Claim—1st, The combination of the lock bolt (of the movable breech), or its equivalent, and the discharging lock of the arm, with intermediate parts. 2d, Arranging the lock for the tape-primers, in the manner described.

51. **Construction of Prisons**; Edwin May, Indianapolis, Indiana.

Claim—1st, The angle door, in combination with the safe lock or bolt, constructed as set forth. 2d, The safe containing the drum and bolt, and being held by the outer door, constructed as set forth. 3d, The endless chain or rope, in combination with the levers, constructed as set forth. 4th, The combination and arrangement of the levers, bar, and bolts or lugs, operated from without the grating, as set forth.

52. **Back-sight for Fire Arms**; Edward Maynard, Washington City, D. C.

Claim—1st, The grooved cylindrical end of the sight carriage, in combination with a spring-bolt or pin, of such form that it shall fall into the grooves and bear against their two sides, and yet not touch the bottoms of the grooves, so that, as it wears, it will still press on the side of the grooves, and hold the carriage firm in either of its positions. 2d, Placing the spring and its bolt or pin within the stock or breech of the gun for its more perfect protection from wet and damage by accident, the opening through which the pin acts being susceptible of being closed without oil or packing.

53. **Nipples of Fire Arms**; Edward Maynard, Washington City, D. C.

Claim—The permanent union of a cap or nipple with the closed end of the tube, whose open ends have screw-threads formed within it, by which I am enabled to combine the said nipple and its tubular seat with the abutment of the breech piece of a fire arm, by means of a transverse perforation in said abutment, for the reception of the tubular nipple-seat, and a nick-headed screw inserted in the left-hand of said perforation, and working into the screw-threads in the open end of said tubular nipple-seat.

54. **Skates**; John McCluskey, Jr., South Boston, Massachusetts.

Claim—The jointed heel strap, in combination with the toe strap, when the latter is made longitudinally adjustable upon the runner.

[The invention further consists in hinging the heel strap and plate to the rear of the runner, and fixing it rigidly thereto when the skate is on the foot, by a suitable spring-catch or thumb-screw.]

55. **Window-sash Supporter**; Wm. Howard Mitchell, San Francisco, California.

Claim—1st, The roller, arranged on an angular double-jointed arm, so as to have slight play up or down between two stops, accordingly as it is operated on by a spring or the weight of the sash. 2d, The combination of the angular double-jointed arm, spring, thumb-piece, friction roller, and semicircular recess in the window frame.

56. **Gold-washer**; Mortimer Nelson, City of New York.

Claim—1st, The combination of a series of concave plain pans with a series of convex rifled pans, said pans all being arranged on the same vertical shaft. 2d, The arrangement of a horizontal cam wheel, ball, horizontal friction roller, two bevel wheel, a rising and falling driving shaft, and a collar on the vertical shaft. 3d, The combination of a revolving perforated platform or grating with a non-revolving but yielding raking device. 4th, The combination of the stationary case with the revolving perforated platform, raking device, and the horizontally-revolving pans.

57. **Composition for Soap**; Nelson Orcutt, Binghampton, New York.

Claim—Making soap from untried or unrendered tallow or grease, and the other ingredients named, the ingredients being in the proportions as stated.

58. **Combined Table and Clothes-dryer**; Lewis Pagin, Elmore, Ohio.

Claim—A combined table or stand and a clothes-dryer, composed of a table or stand, with a reversible top, and a box, drawer, or recess, and two or more jointed arms that will fold up and lie within said box, drawer, or recess.

59. **Upholstery Nail**; Benjamin S. Pardee, Mount Carmel, and Thomas Rawlings, New Haven, Connecticut.

Claim—The paper-headed nail or tack, as described.

60. **Composition for Tanning**; Seneca Pierce and Frederick F. Beadsley, Castle Grove, Iowa.

Claim—A composition for tanning, made of terra-japonica, alum, glauber salts, and saltpetre, in the proportions and manner set forth.

61. **Mode of Restoring Rancid Butter**; Josiah W. Prentiss, Pultney, New York.

Claim—The mode described of restoring rancid butter in the firkin by removing the hoops so as to open the joints enclosing it in a bag, or other textile fabric, and then surrounding the whole with charcoal.

62. **Machine for Lasting Boots and Shoes**; James Purmton, Lynn, Massachusetts.

Claim—The clamps, in combination with the slides, said clamps and slides being carried to their place by their levers, or their equivalents. Also, the opening and closing slide; also, the roughing or cutting slide.

63. **Lathe Chuck**; Edward A. L. Roberts, City of New York.

Claim—The application and use of the ball and socket joint, in combination with the mandrel or chuck of lathes.

64. CORN PLANTERS; Christian Ropp, McLean County, Illinois.

Claim—The arrangement of the dog-wheel, levers, stops, u and u', with stops, f, springs, bent rods, and feed wheels, constructed as set forth.

65. CHEESE VATS; O. Sage, Wellington, Ohio.

Claim—The combination of the furnace and smoke-pipe with the open and curved bottom of the water box, pipe, equalizer, and milk box, arranged as set forth.

66. GRAIN SEPARATORS; Jacob Seebold, New Berlin, Pennsylvania.

Claim—Attaching the separator to the thresher by rocking frames, in combination with wheel, rod, slotted arm, and springs, for producing its reciprocating motion.

67. SURVEYING INSTRUMENT; Samuel R. Seibert, Munising, Michigan.

Claim—Constructing the "Ys" or supports of the telescope in a surveying instrument, as set forth—also, constructing a clamping pinion, in the manner described.

68. DIVIDERS FOR HARVESTERS; J. H. Shireman, East Berlin, Pennsylvania.

Claim—The combination of the adjustable case with the stationary horizontal dividing point, arranged in the manner set forth.

69. OYSTER DREDGES; Thomas P. Sink, Fairton, New Jersey.

Claim—The arrangement and combination of the chuck or block and its pulley, with the roller, in the manner set forth.

70. SAW-SET; Seymour Smith, Sharon, Connecticut.

Claim—The mill saw-set described, the several parts A, B, and F, being arranged in the manner set forth.

71. COVERING COFFINS; Leonard Snyder, Indianapolis, Indiana.

Claim—Using and applying flock as a covering for coffins, whether the same is prepared or secured, or in the manner set forth, or in any other manner substantially the same.

72. HYDRANTS; Charles L. Stacey, Cincinnati, Ohio.

Claim—The relative arrangement of the cup-formed discs and the apertures, adapted in the manner set forth, to form a chamber closed on all sides (with the exception of the ingress aperture) while the hydrant is open, for the purpose of expanding the flanches, and upon the closing of the hydrant to uncover the aperture, and thereby empty the discharge pipe.

73. MODE OF ATTACHING SABRES TO BELTS; James E. B. Stuart, Wytheville, Virginia.

Claim—The attachment hook, in combination with the ring, or its equivalent, attached to the waist belt, the whole being constructed as set forth.

74. SEED PLANTERS; W. H. Stuart, Millington, Maryland.

Claim—1st, A double corn planter, the parts of which are arranged to operate as described. 2d, Connecting the two independent sets of valves by means of the flexible connexion, in combination with single operating chain or cord, as set forth.

75. CONSTRUCTION OF GAS BURNERS; H. K. Symmes, Newton, Massachusetts.

Claim—The combination with the inverted cup and tube, and the quicksilver basin or basins, or their equivalents, forming a movable connexion between the base and tip of the burner, operating as described, of the pawl-like rod, or its equivalent, attached to the cup, and a rest for said rod attached to the base of the burner, the whole operating as described, to shut off the gas from the tip by the temporary increase and subsequent reduction of the pressure in the pipes.

76. TILE MACHINES; George S. Tiffany, Palmyra, Michigan.

Claim—The extension of the flanched feeding shaft, so as to form a revolving core, operating as described.

77. CORN SHELLERS; George W. Tolhurst, Liverpool, Ohio.

Claim—The flexible hinged apron, in combination with the disc and flanch wheel, in the manner described.

78. SPRING BED-BOTTOM; Philip Ulmer, City of New York.

Claim—The method described of connecting the spring, or its equivalent means, by which the same is secured in place by contact between compressing surfaces.

79. CORN PLANTERS; Rufus M. Varmer, Oxford, Mississippi.

Claim—The arrangement of the table, delivering tube, furrow plough, feeding disc, hopper, all attached to the rear end of the tongue, and placed between, and subject to the action of, the straps and the springs. Also, the combination of the spaces of the hopper's side with the india rubber strip, the beveled edge of the hopper's bottom, and the gouged holes of the feeding disc.

80. MACHINES FOR HOISTING ICE; John Wagner, Philadelphia, Pennsylvania.

Claim—1st, The combination of the slides, carriages, supporters, and projections on the chutes, arranged in the manner specified. 2d, The anti-friction rollers in connexion with the slides, arranged as specified. 3d, The counterbalancing rope or chain and rollers, in combination with the pulley and the slides, operating in the manner specified.

81. SEWING MACHINES; Kasimir Vogel, Chelsea, Massachusetts.

Claim—1st, The employment, in combination with two or more needles, or their equivalents, which work together to perforate or pass from one side to the other of the cloth, or other material to be operated upon, and with suitable means of carrying a locking-thread through the loops of the threads of those needles; of a thread conductor, so applied and operated as to effect the interlacing of the threads of said needles on the opposite side of the material to that on which they are interlaced with the locking-thread, whereby they are made to produce the different kinds of stitching represented. 2d, The employment of a movable needle-plate, containing two or more needle-holes, of different size, form, or arrangement, applied to the bed-plate or work-plate of a sewing machine, in such a manner as to be capable of adjustment to bring either of its holes into position for the proper needle to work in it.

82. GUIDE-RINGS FOR FISHING-RODS; Henry Pritchard, Brooklyn, New York.

Claim—The combination of the fixed ferrule and the movable thimble with its eye, constructed as set forth.

83. FURNACES; John I. Vinton and Edward John, Ironton, Ohio.

Claim—The employment in reverberatory furnaces of the water space, constructed and fitted in place in the manner set forth.

84. CLOTHES-CLAMP; Chapman Warner, City of New York..

Claim—The mode of securing, between the buttons A and C, the garment, or whatever else may be placed between them, by means of binding or wedging effect of the pin in the hole of button, C, with the spiral spring, as specified.

85. MACHINERY FOR TRIMMING WALL-PAPER; A. L. Whipple, Elmira, New York.

Claim—The manner of constructing the spool with fixed rotating head and yielding head, in combination with the movable bed for holding the roll firmly in the proper relative position to the knives.

86. HARVESTERS; David Zug, Shaefferstown, Pennsylvania.

Claim—The combination of the brace with the gum-elastic stuffing-box and the supporting bar, arranged in the manner described.

87. KNITTING MACHINES; Wm. Binkley, Assignor to Samuel N. Bell, Manchester, New Hampshire.

Claim—The hollow cone cut off elliptically, and with the parallel elliptical cam on its inner surface, together with the projection on the lower side, supported by the shaft passing through the hollow shaft, and attached to the arm of the standard, or other equivalents.

88. CORN HARVESTERS; Waldren Beach, Assignor to self and John L. Reese, Jr., Baltimore, Maryland.

Claim—The vertically adjustable cutting apparatus, in combination with rests, lever, jointed arms, and spring, operating as set forth.

89. STRAW-CUTTERS; A. D. Brown, Assignor to Sallie C. Brown, Columbus, Georgia.

Claim—The arrangement and combination of the yielding strips and constituting guard, with the wheel, sash, and trough, as described.

90. SKELETON SKIRTS; James Draper, Assignor to self and Samuel H. Dougherty, City of New York.

Claim—The skeleton skirts described, in which the hoops are secured by glue, or equivalent cement, between separately woven parts of the tapes, in contradistinction to the stitched or clasped skirt when the parts are woven together as single tapes between the hoops, and separately as distinct tapes, at the points where the hoops are received.

91. CONSTRUCTION OF DENTISTS' CHAIRS; Nathan C. Lewis, Jr., Assignor to self and Edwin Bruce, Boston, Massachusetts.

Claim—The combination of the adjustable body-rest with the chair. Also, the combination of the auxiliary or elbow-rest and the body-rest, applied to a chair. Also, the mode of applying the body-rest to the elbow-rest, that is, by means of an adjustable arm, applied and operating with respect to the elbow-rest, as set forth.

92. LINING UNDERGROUND DRAINS; James C. Miller, Irwin, Ohio, Stillman A. Clemens, Rockford, Illinois, and Gilbert H. Clemens, Urbana, Ohio.

Claim—1st, The method of making covered field-drains by lining the inside with hydraulic lime, mortar, or other suitable material. 2d, A conducting tube connected with a coulter. 3d, A forcing bar, with valve pistons attached, and working in a conducting tube. 4th, A follower of less transverse dimensions than the mole to which it is attached.

93. ROTARY DREDGING MACHINE; James Molyneux, Bordentown, New Jersey, Assignor to the Bordentown Machine Company.

Claim—1st, The combination and arrangement of devices for raising, lowering, and holding the levers, C C, which support and carry the dredging wheel as required. 2d, The rams on the dredging wheel, for the purpose set forth. 3d, The chute, hinged so that it may be raised when the socket passes under it, and lowered to receive the contents of the bucket. 4th, And, in combination with a hinged chute, I claim the arm on the wheel, just before the bucket, for the purpose of raising the chute and allowing the bucket to pass under it. 5th, A chute arranged to traverse on ways, so as that it may be adjusted to the dredging wheel. 6th, The levers and links, arranged for the purpose of traversing the chute. 7th, The traversing bars, armed with picks or chisels, and arranged to operate on the bottom of the river, in advance of the dredging wheel. 8th, The shaft and wipers, in combination with the traversing bars, carrying picks, chisels, &c., for the purposes specified.

94. CONSTRUCTION OF DISTILLING APPARATUS; John Sloan, Assignor to self and Eberhard H. Dierker, Pittsburgh, Pennsylvania.

Claim—1st, The combination and arrangement of the condensing worm or pipe, the wheels, the receiving chamber, with the governor and valve, for the purpose of regulating the quantity of steam in the heating pipe. 2d, The combination and arrangement of the chambers with the conducting pipes, when used in connexion with the condensing worm or pipe, as described.

95. TRACE-TRIMMER; Adolph Stempel, Assignor to self and Owen McFarland, Newark, New Jersey.

Claim—1st, The arrangement and combination of the vertically sliding spring bar, laterally adjustable bed-pieces, and suspended curved cutters. 2d, In combination with the bed-pieces and cutters, I claim the adjustable jaws, or their equivalents, arranged as specified.

96. MOULDING STOVE-COVERS; David L. Stiles, Assignor to John M. French & Co., Rochester, New York.

Claim—The employment of the cone-form plugs and pivoted thumb-levers, in combination with that portion of the pattern which forms the recess of the cover.

97. RAILROAD CAR BRAKES; William F. Stewart, Patuxent Forge, Maryland.

Claim—The combination of the various parts of the apparatus described, when so constructed and arranged in relation to the means by which they are actuated as to apply and release the brakes upon the whole train, upon sections or upon single cars, by the engineer, or by one or more of the brakemen, or by all or part of them, collectively or individually, the brake apparatus of each car or of each section being complete in itself when the cars are uncoupled or the train divided into sections.

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98. ROPE-NIPPER; W. H. Allen and A. J. Bentley, City of New York.

Claim—The rope-pinchers, composed of the grooved pivoted jaws and levers, as described.

99. GALVANIC BATTERY; Thomas C. Avery, City of New York.

Claim—1st, The use of the insulating amalgam, in combination with the surfaces of the zincs of galvanic batteries for telegraphic purposes, for obtaining the results before set forth. 2d, The use of two or more independent strips of platinum in the construction of galvanic batteries for telegraphic purposes, as an improvement on the Grove Battery, for the purpose of obtaining the results before set forth, but irrespective of their use, in combination with the insulated amalgamated zincs before described.

100. MACHINE FOR BENDING WOOD; Augustus Bailey, Gardiner, Maine.

Claim—The combination of the aforesaid horizontal sliding roll and graduated hook with the semi-cylinder, acting in the manner described.

101. COMPOSITION FOR PAINT OIL; J. D. Baldwin, Columbus, Georgia.

Claim—The paint oil, composed of the ingredients specified, essentially in the proportions named and prepared, as described.

102. STEAM BOILER FURNACES; W. D. Ballard, Kansas City, Missouri.

Claim—The arrangement of the fire-place, the partitions of the setting, and the chimney, as described, with the two-flued boiler.

103. SIGNAL-BELL; G. F. and D. H. Benckert, Philadelphia, Pennsylvania.

Claim—1st, The latch, operating with the hammer and pull-bell, with the one spring. 2d, Placing the working parts of a signal-bell within the sounding box, as specified.

104. HEMMING-GUIDES FOR SEWING MACHINES; S. E. Blake and Thomas Johnston, Louisville, Kentucky.

Claim—1st, The combination and arrangement of the spiral tongue, flanched roller, and yielding plate, for the purpose set forth. 2d, The spring plate, constructed as described, with an oblique slot in the limb, combined with the adjustable gauge. 3d, The yielding pressure roller, adapted and applied to smooth and flatten the hem previous to stitching.

105. CONNECTING RODS APPLIED TO CRANKS; Reinhold Boeklin, Jersey City ,New Jersey.

Claim—Giving the rod elasticity, both longitudinally and in a lateral direction, parallel with the plane of revolution of the crank, by extending it in the form of a bow or arc beyond the crank-pin or wrist, and making such bow elastic.

106. MACHINES FOR BREAKING AND CLEANING HEMP; J. K. Booton, Luray, Virginia.

Claim—1st, The combination and arrangement of the cylindrical grating and lever arms, and swords, and concave grating, with the hurder cylinder, formed with alternate plane edges and serrated ridges or ribs. 2d, The combination and arrangement of a fan or blast wheel with the hurder cylinder and endless apron.

107. TELEGRAPHIC MACHINE; L. Bradley, Folsom, California.

Claim—1st, Arranging the type and mechanism for closing the circuit, as described, or in an equivalent manner, so that a double closing of the circuit is effected, as each tooth of the type comes in contact with the closing mechanism. 2d, The combination of the type and composing sticks with a yielding insulating plate, carrying the mechanism for breaking and closing the circuit, whereby the contact of the closing mechanism with the face of the type is insured. 3d, The vibrating hook and bar, or their equivalents, in combination with a yielding insulating plate, and type, and sticks, for the purpose of closing the circuit. 4th, The combination of the composing stick and type with the spring, or its equivalent, arranged so that the type are made to form a portion of the circuit. 5th, The combination of the carrying band and mechanism for closing the circuit, with the composing sticks and type arranged on the band in relation to each other, so that the sticks are successively carried forward in the order in which they are arranged, brought into the current, and the message transmitted without interruption. 6th, The combination of the movable platform carrying the recording mechanism with the rotating cylinder carrying the record paper, arranged so that the message as transmitted is recorded in parallel lines on the paper. 7th, Constructing the composing sticks and types, so that the sticks, when filled with the type, shall present an even and flat surface on either side. 8th, The application of a siphon pen, for the purpose of recording the messages. 9th, The inclined plane, arranged in combination with the band, whereby the composing sticks are received from the band in such manner as not to interfere with each other's delivery, and in the same order in which they were placed on the band.

108. REFRIGERATOR; T. B. Burtis, Chicago, Illinois.

Claim—The employment or use of the ice chamber, water chamber, air passages, and a series of provision chambers.

109. GRATE-BARS; John Busby, Moorestown, New Jersey.

Claim—Making the mortises and the tenons on the grate-bars, alternately, one above the other, so that the mortises may be made entirely through the bar, without interfering with the tenons, and so the tenons may extend entirely through the bar without interfering with one another, and be made so long as not to be drawn out of the mortise by the warping or springing of the grate-bars.

110. POTATO-DIGGERS; A. S. Capron and D. S. Davis, Grass Lake, Michigan.

Claim—The arrangement of axle, wheels, and wheel, pinion, crank, and shaft, guides, roller, rake, apron, and hooks, connected together and operating as specified.

111. OPERATING THE VALVES OF STEAM ENGINES; Tisdale Carpenter, Providence, Rhode Island.

Claim—The adjustable, graduated, scroll-shaped side cam, so arranged as to be traversed and adjusted by a regulator or governor, while the engine is in motion, or adjusted and fixed or set by hand while the engine is stopped.

112. AWNINGS; Samuel Chace, Providence, Rhode Island.

Claim—The application of the gear-toothed tracks with the pinions; also, the dogs; and finally, the box or covering to an awning, constructed as set forth.

113. GASKET FOR STEAM AND OTHER JOINTS; James S. Colvin, Allegheny, Pennsylvania.

Claim—A joint gasket, composed of a ring of india rubber, encased with copper or other metal, as described.

114. SPRING-BACK CARRIAGE SEATS; Norman Cowles and A. Hulbert, Edgefield, South Carolina.

Claim—The employment of springs, when in connexion with a back supported by hinged uprights, in the manner set forth.

115. HAND MACHINE FOR WIRING BLIND-RODS; Biram C. Davis, Binghampton, New York.

Claim—1st, The setting form which sets over the rod and straddles the slats, and which is secured under the blind by means of the stationary bar, in such a manner as to let the staples through the eye of the staple in the rod into the slats; D D being the equivalent means employed for setting the staple into the rod, in combination with the adjustable arrangement, operating as described. 2d, In combination with the form, the joint lever, flanch rod or drivers, dividing slide, and inclined needle-bar.

116. WHEELWRIGHT MACHINE; E. Dougherty, Cedarville, Ohio.

Claim—The combination of devices, as specified.

117. SHUTTER HINGE; H. F. Drott, Cumberland, Maryland.

Claim—The employment of the spring, as constructed, when used in connexion with the plate, as constructed, the two being used in combination with any common shutter hinge.

118. FURNACES; B. Wells Dunklee, Boston, Massachusetts.

Claim—The general arrangement of the space, the chamber or dome, I, the dampers, M N, and pipe or T-L, and the ventilating pipe, S, and smoke-drum, and ventilating pipe, P, and smoke-pipe, t, and air duct, and series of dampers in flues, F, in relation to each other and with respect to the flue, F, and hot air chamber, E.

119. SEWING MACHINES; Wm. O. Grover and Wm. E. Baker, Boston, Massachusetts, and O. B. Potter, City of New York.

Claim—A non-penetrating instrument and a piercing eye-pointed needle, acting together to make an interlocking of threads, in combination with a clamping apparatus, acting as specified, and acting to make a double-looped stitch. Also, mounting a spool or bobbin, from which thread is to be delivered, for the purpose of sewing by machinery upon two truncated cones.

120. BEE-HIVES; Horace Gushee and John G. Dawes, San Francisco, California.

Claim—The combination of the comb frames, rods, staples, and cleat, whereby the comb frames may be readily removed or inserted, in the manner described.

121. BEDSTEAD; John R. Guy, Springfield, Ohio.

Claim—The arrangement of the frame with reference to the heads, and their connexion by means of the joints, and slides, and plates, or their equivalents, as described.

122. DOUBLE-FRICTION COUPLING; Joshua Hendy, San Francisco, California.

Claim—The application of two such truncated cones to one coupling (one at either end), and operated by a single lever, so as to work in cavities or conical sleeves attached to pulleys or wheels, arranged on one shaft, so that said shaft may be run slow or fast, or backward or forward, or entirely stopped, without stopping the prime-motor or changing its speed.

123. STEERING APPARATUS; Hatsel Higgins, Orleans, Massachusetts.

Claim—The arrangement of the rudder head intermediately between the supports which, respectively, serve as bearings to the hand-wheel shaft and the rudder-operating gear, said shaft extending back of and over said gear, whereby the rudder may be operated either by the gear or by a tiller from the wheel shaft, as described; and also compactness of steering apparatus and economy of deck space is obtained.

124. HOT-AIR FURNACES; Isaac H. Hobbs, Abraham W. Rand, and George H. Sellers, Philadelphia, Penna.

Claim—1st, The general arrangement of the subdivided air chamber, in connexion with the separate receiving and discharging openings. 2d, The deflecting diaphragms, in combination with the above described arrangement, in the manner set forth.

125. ROTARY HARROWS; Sidney S. Hogle, Cleveland, Ohio.

Claim—The combination of a series of individually rotating toothed frames or wheels, with a rotating central frame or wheel, in such a manner that the said parts will operate in the manner set forth.

126. CLOTHES FRAME; D. E. Holmes, Halifax, Massachusetts.

Claim—The combination of the standards and horizontal hinged frames, when the same are sustained and braced by slotted braces, in the manner set forth.

127. PLOUGHS; Bold R. Hood, Clinton, North Carolina.

Claim—The combination of the standard, D, standard, C, and land slides, when the parts are constructed as described, and adapted to receive the various forms of shovel points and mould-boards in use.

128. TELEGRAPHIC CABLE; William H. Johnson, Springfield, Massachusetts.

Claim—An electric telegraphic conductor, constructed in the manner set forth.

129. OMNIBUS REGISTER; W. M. Keague, Brooklyn, New York.

Claim—1st, The arrangement and combination of the platform, vibrating lever, and adjustable spring, as specified. 2d, In combination with the platform and spring, I claim the sliding bar, spring catch, and wheel. 3d, Arranging the step, in combination with the registering apparatus, as described, so that it registers half-fares as well as full fares.

130. HYDRAULIC MOTORS; Miles Keely and G. W. Cressman, Barren Hill, Pennsylvania.

Claim—The arrangement and combination with the levers, lever frames, and bottoms of the adjustable slots and bars, by which the speed of the machine, length of stroke of the levers, and distance of water may be regulated at pleasure.

131. TEA KETTLES; Archibald C. Ketchum, City of New York.

Claim—The combination of the tin top, copper bottom, and sheet iron skirt, when the same are all united by one and the same lap-joint, and just below the spout of the kettle.

132. ENDLESS CHAINS FOR HORSE POWER MACHINES; Isaac R. Lawrence and George E. Gould, Green Island, New York.

Claim—1st, Extending both the lugs and the links of such chains to or beyond the treads of the friction wheels, carried by axles cast on the links. 2d, Forming and arranging projections on the links of the chain, the links being provided with male lugs and female lugs.

133. Straw-cutters; Lucius Leavenworth, Trumansburg, New York.

Claim—The arrangement and combination of the rockers and springs, for the purpose of giving a double motion to the knife, and to avoid friction of the working parts.

134. Apparatus for Stirring and Delivering Grain; Sylvester Marsh, West Roxbury, Massachusetts.

Claim—1st, The combination with the reticulated bed or other suitable drying table, of a reciprocating truck armed with paddles or stirrers for agitating the grain on the drying surface. 2d, The arrangement of the truck paddles in rows, one in advance of the other, and the paddles of each preceding row intermediate of those next behind them. 3d, Giving to the paddles of the reciprocating truck an oblique set for and during the forward travel of the truck, and giving them an edge presentation or set for and during the back travel of the same, as set forth. 4th, Giving to said paddles reverse obliquities, for and during the forward travel of the truck, so as to throw the grain to the right and to the left, alternately, in the feed forward of the grain by the paddles. 5th, The combination with the reciprocating truck and its paddles, of a cross sliding frame, made to gear by cranks, or their equivalents, with the several paddles, for simultaneously changing the latter from an oblique to a straight set, and vice-versa. 6th, The combination with the cross sliding frame to the reciprocating truck, of one or more adjustable inclines and stops for automatically reversing the position of the paddles in their own direction. 7th, Drawing the cross frame back to its original position, to give to the paddles a different set, by means of a clip-lever, acted on by a weight, weighted catch, and inclined projection, connected with the reciprocating truck, or their equivalents, also afterwards returning said lever to its former position to be locked by the weighted catch by an inclined plane on the truck, acting against and over a swell on the lever. 8th, Varying the range of motion of the reciprocating truck on or over the drying surface, and relatively to the feed or delivering ends thereof, by means of a lengthening and shortening driving pitman, made adjustable.

135. Seed Planters; Andreas Maurer, New Carlisle, Indiana.

Claim—The arrangement and combination of the vertically-moving and seed-distributing supporting axle, and boxes, and lever, as set forth.

[The invention consists in having the axle of the supporting wheel extend through the sides of the frame of the machine, and below the seed boxes, the ends of said axle being provided with seed cells, and the axle allowed a certain degree of longitudinal play in its bearings, so that the seed cells may be shoved underneath the seed boxes or out from underneath them.]

136. Method of Combining Emery with Caoutchouc; Thomas J. Mayall, Roxbury, Massachusetts.

Claim—Making emery sharpening and polishing tools by combining emery with india rubber, gutta percha, or other substances, and then submitting them while under great pressure to a high degree of artificial heat, whereby, with a given quantity of rubber, emery may be combined in much greater quantities than it could be heretofore done.

137. Harvesters; James McAleer, Chambersburg, Pennsylvania.

Claim—The arrangement of the two seats, one facing at right angles to the other, conducting trough, and binding table, and the elevating device, in the manner set forth.

138. Mode of Forming Joints in India Rubber Belting; J. McDougal, Masonville, Michigan.

Claim—The employment, in combination with the belt ends, of the tongues and cavities, so that the sides of the tongue portion shall be protected by the selvedges of the cavity parts.

139. Travelers Ticket-holder; S. T. McDougall, City of New York.

Claim—The lever, spring, point, or other equivalents, in combination with an ordinary shawl pin.

140. Skates; James P. McLean, City of New York.

Claim—The arrangement and use of the side or ankle springs, with parts, B B, and instep projections, adjustable or otherwise, in combination with the heel spring, having a pad at its top end, and with the cork sole in the form of a shoe, or otherwise. Also, the combined arrangement and use of the railroad attachment, as applied to a skate; the same forming a toe-strap loop if required, in the manner set forth.

141. Horse Power Locomotive; James C. Miller, Union Township, Pennsylvania.

Claim—Horse power sweep levers connected with one or more ground wheels.

142. Electro-magnetic Burglar Alarm; George F. Milliken, Somerville, Massachusetts.

Claim—The combination of a galvanic battery, an electric circuit, circuit-breaker, operated by a window or door, with a step by step indicator. Also, causing a window or door automatically to prevent any alteration upon the circuit during the closing of the window or door, until it is nearly closed, in any manner substantially as described. Also, the use of the armature for the double purpose of regulating the movements of the points and setting in motion the alarm apparatus.

143. Cultivators; B. S. Morgan, Delhi, Iowa.

Claim—The arrangement and combination of the side wings and wheels of a cultivator, with the levers, bar, rods, and hand lever, as specified.

144. Boot and Shoe Brush and Scraper; Wm. Morrison, Morrisiana, New York.

Claim—The arrangement of the springs, in combination with screws, in such a manner as to throw the brushes forward parallel with the scraper.

145. Hand Looms; Abel R. Nixon, Rhea Spring, Tennessee.

Claim—In combination with the lay beam and spring picker-staffs, the toggle-levers, b b, triggers, and flexible connexions, for effecting the setting and tripping of the picker-staff. Also, in combination with the lay and the treadles for working the harness or sheds, the toggle-levers, q, and trigger-cords, so that the shed shall be properly made before the trigger is drawn to let the shuttle fly, thus insuring a perfect sequency of operation, and with great saving of manual labor on the operator.

146. Varnish; Samuel Page, Chelsea, Massachusetts.

Claim—The described varnish, made of the materials specified.

147. Sole-cutting Machines; William Munroe, West Auburn, Maine.

Claim—1st, The arrangement of the vertical slots in the arbor, elastic bars, with their projections, fitting respectively in said slots; the weight, bar, and the shafts, provided respectively with the cam, spring, pinions, part pinion, and strap, to operate the arbor and its die or cutting flanch. 2d, The stop, attached to a shaft provided with springs, and actuated by the pin on the rod, and the notched block attached to the bar.

148. GEAR-CUTTING ENGINES; Henry Pfaner, City of New York.

Claim—A pattern mounted on a shaft or spindle, which also carries the gear to be cut, in combination with a fixed dog or guide, when said dog or guide is so located that the pattern runs off and is clear of the same, so as to be turned at the time the gear is clear of the cutter, and said pattern again takes and is held by said dog, as the cutting commences, and is proceeded with. Also, the arrangement of the lever, pawl, and adjustable stop, to give motion to the pattern when not in contact with the stop or dog. Also, in combination with the pattern and dog, the stock carrying the shaft or spindle, and actuated by the lever.

149. KEY-BOARDS FOR PIANO-FORTES; Mathieu Philippi, Troy, New York.

Claim—So constructing the upper surfaces of the keys of a piano-forte, that while the ordinary form of the key-board is retained, portions of all the keys are brought to the same level in the key-board.

150. HARVESTERS; Henry B. Ramsey, Indianapolis, Indiana.

Claim—The combination of the frames, chain, chain-wheel, crank, screw-rod, friction bearers, and grain table, arranged in the manner set forth.

151. LASTING-PINCERS; L. B. Richardson, Athol, Massachusetts.

Claim—The application of a swinging fulcrum to lasting-pincers, arranged in the manner set forth.

152. UMBRELLA FRAMES; Robert E. Rogers, Philadelphia, Pennsylvania.

Claim—Combining, with the tubular ribs and stretchers, the means for uniting the ribs and stretchers, and for strengthening the tubular parts of the frame, as set forth.

153. CULTIVATORS; William Seeley, Chillicothe, Illinois.

Claim—The arrangement of the post, arms, cross-bar, lever, wheel, shovels, chains, arms, cross-bar, vertical lever, rods, whiffle-tree, and draft hook, combined in the manner described.

154. MAKING SPOONS; Joseph Seymour, Syracuse, New York.

Claim—The machine known as the "rolls," having the former or figure of any article to be made up plain, of silver or other metal, cut upon one or both of them, so much larger than the same article when finished, that the article itself can be cut with a punch of the desired size and shape, out of a piece of metal after it has been passed between the rolls, and entirely within the margin or edge of the impression made upon the metal by the form or figure cut into one or both of the rolls.

155. INVALID BEDSTEAD; H. O. Sheidley, Republic, Ohio.

Claim—The combination of the sliding hinged bottom with the crank shaft, cords, and attached levers, and the movable foot board.

156. CUTTING AND PANNING CAKES; John H. Shrote, Baltimore, Maryland.

Claim—The cutters, as constructed, or their equivalents, in combination with the pan and bottom board, for the pupose of facilitating the cutting and removing the cakes to the oven.

157. DEVICE FOR BRACING AND VENTILATING FENCE POSTS; Charles R. Smith, Haverhill, New Hampshire.

Claim—1st, The peculiar construction and arrangement of the wire loop, in combination with one pair of braces, a post, and a sill. 2d, The grooved post and the grooved cleats, in combination with the lengthwise boards or slats.

158. GOVERNORS FOR STEAM AND OTHER ENGINES; A. D. Snow, Rochester, New York.

Claim—The use of collar, first, to control the passage of steam through the valve on starting the engine; secondly, to control the extreme downward movement of the valve by means of stops, so connected with the valve openings as to close them at either extreme of the movement. Also, locating the weight beneath, and partially entering the tube of the valve.

159. CUTTING AND ATTACHING LABELS; C. M. Spencer, Manchester, Connecticut.

Claim—The cutting and affixing labels upon spools by one or the same action of a machine as the dies, on the tubular cutters, follower, or their equivalents.

160. ADJUSTABLE RAILS FOR REPLACING CARS ON THE TRACK; Joseph Andrew Stephan, Lafayette, Indiana.

Claim—1st, The fish pieces clamped to the permanent rails, and elevated high enough above said rails to carry the flanches of the car to be replaced over them. 2d, In combination with an elevated temporary track, secured to, and high enough above the permanent track to carry over the flanches of the wheels, the sections, and their switches extending to each of the pairs of wheels of the car, said sections having all the elements of switches, frogs, and rails.

161. METHOD OF PREPARING BONES FOR FERTILIZING PURPOSES; David Stewart, Annapolis, Maryland.

Claim—The stratification of the bones with materials, animal, vegetable, and mineral, substantially in the order and upon the principles set forth, using the materials above designated, or their equivalents, whereby bones are reduced in a most economical manner to an available condition for manure, and a thorough compost obtained adapted to all the necessities of growing and fruiting plants without any mechanical labor other than that of stratifying, cutting down, and screening.

162. MILK SAFE; William H. Tambling, Berlin, Wisconsin.

Claim—The described safe, constructed with gauze wire sides and doors, and with shelves, which consist of longitudinal slats, to which are secured a series of wooden cross slats, which are made broad at their base and beveled to an edge at their tops.

163. WASHING MACHINE; William H. Tambling, Berlin, Wisconsin.

Claim—1st, The arrangement of their buckets in the four corners of the interior of the box, said buckets being made in a triangular form and open at one angle. 2d, The arrangement of the bars as provided with pins, and in the form represented, when used in connexion with the box and the buckets, as specified.

164. MAKING CYLINDRICAL STRIPS OF DOUGH IN THE MANUFACTURE OF CRACKERS; Francis C. Treadwell, Jr., City of New York, and Henry McCollum, Windham, Connecticut.

Claim—The method of forming the skin-covered strips from a sheet of previously smooth-rolled dough, by passing it between a pair of grooved rollers, arranged as described, with the groove separated by portions of the plane surface of the rollers.

165. APPARATUS FOR VENTILATING RAILROAD CARS; John G. Treadwell, Albany, New York.

Claim—The arrangement of the boxes, of the porous partitions, and the pipe, provided at its lower end with a sprinkler, used in connexion with the openings, in the manner specified.

166. GRAIN CLEANERS; Isaac Wait, Watertown, New York.

Claim—The combination of the separating sieves and the burr surfaced plates, by means of the vibrating lever, which gives a contrary motion to each at every revolution of the wheel or crank.

167. LOCOMOTIVE CROSS-CUT SAWING MACHINE; John Walker, Sunbury, Ohio.

Claim—1st, The arrangement of an upright steam engine on a truck frame, with a horizontal crank shaft and a vibrating saw. 2d, The employment of conical pulleys and shiftable bands, in combination with the other machinery and the engine which operates the saw, for the purpose of guiding the machine when moving from place to place.

168. CUTTING SCREW THREADS ON GAS PIPES; Caleb C. Walworth, Boston, Massachusetts.

Claim—The combination of two or more mandrels parallel, or nearly parallel, to each other, and arranged to carry cutting tools with two or more vises, arranged to revolve round a common centre. Also, the combination of two or more sets of mandrels, as above, with two or more sets of vises, as above, each set of mandrels arranged to operate in unison with its corresponding set of vises. Also, the combination of two or more series of vises, one beyond the other, and arranged to revolve about a common centre. Also, operating two or more vises, independently of each other or together, by one wrench, and by the means and in the manner specified.

169. BED-BOTTOM; Daniel Winder, Cincinnati, Ohio.

Claim—The combination of the rings and tension screw, operating in connexion with a radial bed-cord or webbing, in the manner set forth.

170. LIFE-PRESERVING BUOY; Oliver Evans Woods, Philadelphia, Pennsylvania.

Claim—A buoy arranged with two frames, stays, and cross braces, and with a valve or valves, and otherwise constructed and operated as described.

171. SEWING MACHINES; Francis G. Woodward, Worcester, Massachusetts.

Claim—The peculiar manner of working the looping hook by means of the wheel and the double joint, as specified.

172. BURNISHING MACHINE; Le Roy S. White, Waterbury, Connecticut.

Claim—1st, The arrangement of the burnisher or burnishers in a burnishing machine in a sliding gate, or its equivalent, carried by, and working perpendicularly to, a rectilinear reciprocating shaft, or its equivalent. 2d, Providing for the burnisher or burnishers employed on one side of the article to be furnished, in a so-applied gate, or its equivalent, such a movement independently of that or those employed on the opposite side, as to produce the greater movement that is necessary or desirable, for the reason explained, on the convex side of any article of curved form. 3d, Fitting a burnisher in a burnishing machine to a suitable holder, or its equivalent, in which it is permitted a free vibration, laterally, to the movement it makes in the burnishing operation.

173. MODE OF MANUFACTURING BARRELS, &c.; George W. Banker, Medford, Assignor to self and G. O. Carpenter, South Reading, Massachusetts.

Claim—The method described of securing the heads of casks, by means of the chamfer and shoulder. Also, a keg furnished with ears and a bale, as described.

174. SEWING MACHINES; Oliver D. Barrett, Assignor to self and Lears E. Smith, Cleveland, Ohio.

Claim—1st, The crank, consisting of the disc and pin, in combination with the pin in the pulley and hinge, whereby I am enabled to turn the machine up from the table designed for it to stand on, in order to adjust or thread the under needle, without unbanding the machine. 2d, Hinging the foot-holder to the head of the goose necks, in a position vertical to the feeding surface of the feeder. 3d, The foot-holder, constructed and hinged as set forth, in combination with the rod, spring, foot, and feeder.

175. BUSTLES; Thomas A. Earl, North Attleborough, Massachusetts, Assignor to self and Charles A. Durgin, City of New York.

Claim—The segment, supported in combination with the projecting strut, slide, and strip, constructed as set forth.

176. COMPOSITION FOR PREPARING GOLD AND SILVER ORES FOR AMALGAMATION; Wm. Gluyas, Assignor to self and Wm. H. O'Neill, San Francisco, California.

Claim—The mixture or composition described, used with pulverized ores or tailings, the whole being brought to a boiling heat and being constantly agitated, thereby preparing the precious metals for a more perfect amalgamation with quicksilver.

177. BURGLARS ALARM; Stoughton B. Holden, Woburn, Assignor to self and Parker Nichols, Reading, Mass.

Claim—The arrangement of the candle-carrier and its hammer upon the torpedo post or standard, the trigger lever, and the grate or friction plate.

178. STRAW-CUTTERS; John S. Lash, Carlisle, Assignors to self and Franklin Knauss, Allentown, Penna.

Claim—Forming the bed in sections, each being provided with a spring, and having the spiral beaters or followers provided with shoulders, to prevent the lateral movement of the straw or stalks in the feed-box, under the action of the beaters or followers.

179. METHOD OF PREVENTING DEPOSITION OF CARBON IN GAS RETORTS; Alfred Marsh, Assignor to John Q. Dudley, Detroit, Michigan.

Claim—The introduction into the retort, during the gas making process, of chlorate of potash, or other substance, which evolves oxygen when heated.

180. TOOL FOR CUTTING ROUND TENONS; Charles O'Bryan, Assignor to self and Joseph S. Haldeman, Salem, Ohio.

Claim—The combination of the hollow conical head, external nut, and plate, arranged for adjusting and holding, when adjusted, the bits or cutters, or their guides.

181. SOLUTION FOR THINNING LUBRICATING COMPOUND; Robert Patterson, Philadelphia, Pennsylvania, Assignor to Horace Vaughn, Providence, Rhode Island.

Claim—A thinning solution applicable to the reduction of the lubricating compound, described in the patent of Vaughn & Hutton, dated Aug. 2, 1859, made of the substances and applied in the manner specified.

182. PEN AND PENCIL-HOLDERS; Thomas D. Richardson, Assignor to W. Richardson, City of New York.

Claim—The arrangement and combination of the elongated tube with the handle and tubes, as and for the purpose described.

183. Regulator Valve for Steam Engines; Nathan C. Travis, Assignor to self, Nathan Johnson, and Richard Emerson, Alton, Illinois.

Claim—The arrangement and combination of the valve-box and casing, as described. 2d, The arrangement and combination of the screw socket, stem, rod, arm, groove, and band-wheel, so that by turning the band-wheel, the stem may be elevated and depressed irrespective of the rise and fall of the rod, and without rotating the latter.

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184. Adaptation of Wads to Shots and Shells; S. C. Abbott, Zanesville, Ohio.

Claim—In combination with a shot or shell, that receives its rotation by the action of the atmosphere in its flight, and which has an open funnel-shaped base, a similarly-shaped open wad or packing, that when expanded by the gas, shall impinge both upon the bore of the gun and the interior of the shot or shell.

185. Jacquard Machines; Avery Babbitt, Auburn, New York.

Claim—1st, Arranging two or more trap-boards in one frame, in such manner that when all the said trap-boards, so arrang d, are lifted, for the purpose of opening the shed, all the untrapped knot cords may pass said trap-boards without obstruction, in combination with an ascending and descending suspension board. 2d, In combination with the Jacquard machine, I claim the device represented on the sides of the machine for working the journals, or parts of journals, consisting of the pin-wheel, shaft, hooks, y y, and the hooks, o o, and the dog. 3d, Dividing the journals commonly used in two or three ply Jacquard weaving machines, and working them in any required order.

186. Harvesters; E. Ball, Canton, Ohio.

Claim—1st, The hinged plate, constructed as specified, in combination with the finger bar and brace-plate. 2d, The combination of the coupling arm (swiveled only at the point of connexion with the main frame), in combination with hinged plate, hinged brace-plate, and guide-piece. 3d, The guide-piece, in combination with the brace-rod, hinged plate, brace-plate, coupling arm, and chain. 4th, The combination and relative arrangement of spur, with coupling arm and pitman. 5th, The combination of the hinged plate and adjusting screw with the slotted guide-piece, hinged brace-plate, and chain.

187. Steam Engines; Daniel Barnum, City of New York.

Claim—The method of constructing and combining adjustable cut-off cams and adjusting screws, and a revolving and sliding rock shaft, and of combining those with the means described, for working puppet valves in steam engines. Also, the method of constructing, or using, or adjusting the cut-off cams, for the purpose of enabling me to fix or to adjust the point at which the steam is to be cut off, during any portion of the stroke, whether it be done while the engine is in motion or at rest.

188. Construction of Vapor Lamp Burners; Wm. W. Batchelder, City of New York.

Claim—Modifying the flame under the retort, by means of the wires, or their equivalents, in such manner that the deposit of carbon shall be prevented, and the blue flame produced. Also, deriving the gas for heating the retort from the gas pipe after its commixture with air, and before it reaches the illuminating jet, by means of the aperture, as set forth.

189. Cheese Hoops; John Beach, DeRuyter, New York.

Claim—1st, A hoop, having a cross-cut or division at its periphery, and constructed to open or close, as described, when provided, on opposite sides of said division, with hood or eye-straps, united by a tie-band of oval configuration, or other similar shape, and serving, in connexion with the eye-straps, to open and close the hoop, and to hold the same, when expanded or contracted. 2d, Providing the oval tie-band to the hook or eye-straps of the opening and closing hoop, with a lever or handle, arranged to cross the oval band, at points intermediate to the intersections therewith of the transverse and conjugate axis of the band, and secured to the band on its one side, but projecting freely through it on the opposite side.

190. Operating Window Blinds; C. G. Bloomer, North Kingston, Rhode Island.

Claim—The segmental disc, or its equivalent, and the spring, or its equivalent, in combination with one of the slats of a blind, when arranged to operate in the manner described.

191. Steam Boiler; M. S. Bringier, New Orleans, Louisiana.

Claim—The arrangement of a series of horizontal tubes or pipes, connecting two cylindrical chambers or reservoirs of water and steam, in combination with the steam cylinder connecting the same chambers.

192. Smoking-tube; William M. Bryant, Washington City, D. C.

Claim—A tubular tobacco pipe, which contains the supply of tobacco within it, and is furnished with a spring and follower, or their equivalents, that force up the tobacco to the burning point or chamber as fast as it is consumed.

193. Churn; S. N. Campbell, Elgin, Illinois.

Claim—The arrangement and combination of the button, dasher rod, movable slats, pieces, and bar, as described.

194. Construction of Hydrants for Filtration; John H. Carter, Cincinnati, Ohio.

Claim—The cylindrical inner vessel within the case, and made removable, in combination with the receiver for receiving the sediment, and the cap for favoring the direction of the sediment downward, in the manner set forth.

195. Operating Gun Carriages; Asa L. Caswell, Lansingburgh, New York.

Claim—1st, Returning the gun up to the port-hole, after being discharged, by means of a roller and cords, or chains, operated by a lever, or its equivalent, arranged in the manner, and dispense with the use of gun tackle, as set forth. 2d, The manner described, or equivalently the same, for securing the gun and carriage in a fixed position upon the truck, so as to maintain a given range for any number of discharges.

196. Hem-folders; Leverett Clark, Monticello, New York.

Claim—The hem-folder, composed of a straight gauge and adjustable plate, and a bar, the whole combined as described, either arranged as shown in figs. 1, 3, and 4, or as in figs. 2, 5, and 6, and operating as described.

197. Method of Opening and Closing Gates; B. R. Cole, Geneva, New York.

Claim—The arrangement of the bar to the levers, at such points as to give their lower ends the same motion inward or outward at the same time, as set forth.

198. MACHINES FOR SAWING BEVELED CURVES; Jonathan Creager, Cincinnati, Ohio.

Claim—1st, The combination of the inclined rest with a crown saw, for the production of a crowning cylindrical segment. 2d, The combination of a rocking rest with a crown saw, for the manufacture of a cylindrical segment having oblique axes.

199. TRY-COCK FOR STEAM BOILERS; James Cumming, Boston, Massachusetts.

Claim—The combination with an ordinary try-cock of a straight hollow tube, moving vertically on axis, and which is also the indicator at its outer closed end, and extending through the end or side of the boiler, and at certain periods remaining elevated above the level of the water, but capable of being brought below the same whenever necessary.

200. FEED-WATER APPARATUS FOR STEAM BOILERS; Wm. P. Curry, Vincennes, Indiana.

Claim—The arrangement of the rods, or their equivalents, to operate in combination with the discs, or their equivalents, and with the float and stop valve.

201. OPERATING FIELD GATES; Andrew J. Curtis, Frankfort, Maine.

Claim—The improved arrangement of mechanism described, for opening and closing a gate, the same consisting of the lever and the connecting rods, applied to the said lever and the gate posts. And in combination therewith, I claim the peculiar arrangement of the block, the same operating in connexion with the lever, in the manner specified.

202. CONSTRUCTION OF EVAPORATING APPARATUS; J. B. Dagne, Ashley, Ohio.

Claim—The employment of the pan which is provided with two or more compartments, and situated over a furnace, when said pan is used in connexion with the slides and damper, combined and arranged in the manner set forth, for the purpose of forming a sugar evaporator.

203. SLEEPING CARS; John Danner, Canton, Ohio.

Claim—1st, The combination of the hinged false back with the permanent back, a, as set forth. 2d, Making each alternate back with a false back, in combination with making each alternate back shorter than the backs, a, and hinged to the seat, as set forth.

204. HARVESTERS; John Ebner and Frank Lenthy, Lancaster, Pennsylvania.

Claim—The arrangement of the three eccentrics and revolving shaft of the driving wheel, in combination with the rake-connecting mechanism, constructed in the manner described.

205. PLOUGHS; Daniel Eldred, Monmouth, Illinois.

Claim—The arrangement for joint operation of the share frames, axle, and coulter, as set forth.

[The invention consists in having two shares attached to movable or adjustable frames secured to one axle, and using an adjustable coulter and axle.

206. PLOUGHS; Gilmore Emery and Aaron C. Wilson, Newfield, Maine.

Claim—The arrangement of the various parts of the plough, when constructed as described.

207. PRUNING KNIVES; Frank P. Goodall, Deering, New Hampshire.

Claim—The combination of pruning knife and arm rest, arranged as specified.

208. MACHINES FOR CRUSHING QUARTZ; Merritt Goodman, Whitlocks, California.

Claim—A revolving mortar or stamping-bed, in combination with a hollow stamp and shaft, as described.

209. CLOTHES-RACK; Oliver C. Green, Dublin, Indiana.

Claim—The arrangement and combination of the centre posts, arms, and braces, operating in the manner set forth.

210. FIELD FENCES; Joel Haines, West Middleburgh, Ohio.

Claim—The peculiar construction of the braces so as to adapt them to the keys, when combined with a sill having one or more notches, so as to hold the fence perpendicular when the sill is inclined.

211. APPARATUS FOR PREVENTING HORSES FROM RUNNING AWAY; Wm. Hall, Indianapolis, Indiana.

Claim—The apparatus described, when constructed and operated in the manner described.

212. LIGHTNING-ROD; William Hall, Indianapolis, Indiana.

Claim—The construction of a lightning-rod presenting a great amount of conducting surface in a compact form, when the same is constructed in the manner set forth.

213. HARROWS; Samuel W. Hamsher, Decatur, Illinois.

Claim—The arrangement of the harrow frames, toothed roller, and hinged adjustable arms, as set forth.

214. RAILROAD BRAKES; Joseph Harris, Allegheny, Pennsylvania.

Claim—1st, The combination of the winding apparatus, the weight, lever, rod, bent lever, sliding ring, sleeve, anti-friction ring, conical centre-piece, collar, with friction plates and spring plates, also screws, arranged in the manner of operating a railroad brake. 2d, The combination of the pawl and spring with ratchet and drum, with short chains and rods, the arm with pulleys connected by chains, rods, or ropes, for applying and maintaining the strain of a railroad brake at the centre of each car. 3d, The combination of the rod with the long arm of the pawl and the cross lever, connecting the shaft of the bunter to pawl, for the purpose of setting the brakes free.

215. STEAM PLOUGHS; James Hawkins, Wilkins Township, Pennsylvania.

Claim—The arrangement of the frames, levers, caster wheels, drivers, crank shaft, cutter, toothed cylinders, levers, operating conjointly as set forth.

216. KNITTING MACHINES; Joseph Hollen, Fostoria, Pennsylvania.

Claim—The combination of a needle, the barb of which is pressed by its own spring into its own groove, with a thread-carrier to release the barb and lay the thread therein, and a supporting guide to sustain the needle, when arranged and operated in the manner described.

217. WATER-GAUGE FOR STEAM BOILERS; Francis A. Hoyt, Boston, Massachusetts.

Claim—The described arrangement of the steam whistle, its valve, conduit, and valve seat, relatively to the dry steam chamber and the operating lever of the float.

218. PACKING PISTON-RODS OF STEAM ENGINES; Thomas J. Hudson, Newbern, North Carolina.

Claim—The method of packing the glands, a a, and applying the gland, c, with the packing in d d.

219. CONSTRUCTION OF VAPOR BURNERS; William H. Hunt, Brooklyn, New York.

Claim—The combination, in a vapor burner, of a conic frustrum and draft holes, in combination with the orifice and damper, constructed and combined as specified.

220. OIL-CANS; George P. Hunt, City of New York.

Claim—The arrangement of the valve with the point of the tube or spout, in combination with the extension of the point of the valve for operating it, by which arrangement, when the point of the valve is relieved from pressure, the further discharge of oil from within the tube is prevented.

221. CONSTRUCTION OF COMPOUND BLOW-PIPES; J. Burrows Hyde, Newark, New Jersey.

Claim—1st, The compound conical nozzle, constructed with the projecting tubes, as described, combined with the concentric elastic tubes. 2d, The receiving tubes with their projecting tubes, for attaching thereto the elastic tubes.

222. CORN PLANTERS; A Kirlin, New Boston, Illinois.

Claim—The cam, spring arm, ratchet, and pawl, arranged as set forth and operated by the marker wheels, for giving motion to the rotary hopper bottoms, for planting the corn.

223. CONSTRUCTION OF GAS REGULATORS; George H. Kitchen, City of New York.

Claim—The construction of the valve chamber, having the valve fitted within it, as described, with a series of recesses whose width increases in an upward direction, or an equivalent series of passages surrounding the valve, and having their area of opening increased by the ascent and diminished by the descent of the valve.

224. SEED PLANTERS; Adam Klaus, Belleville, Illinois.

Claim—The valve, in combination with the sliding door, when the same are operated simultaneously with the seed slide.

[This seed planter is provided with covering shares and a cutter, that are so arranged that two small furrows are drawn on each side of the seed, leaving the latter a little elevated in the ground, so that it is protected against being drowned by heavy rains. The seed is deposited on the ground from a discharge tube, in the lower part of which one throw of seed is always kept in store, so that the regularity of the rows is not disturbed by the time which it takes for the seed to reach the ground. The dropping apparatus is also connected with a registering mechanism that serves to keep account of the number of hills planted during a certain time.]

225. STEERING APPARATUS; Jesse S. Lake, Smith's Landing, New Jersey.

Claim—The arrangement of catches, braces, collar, pin, in combination with the barrel, in the manner set forth.

226. MAKING ORNAMENTAL CHAINS; James Lancelott, South Providence, Rhode Island

Claim—1st, The employment or use of the fillings in the female die, Q, when used in connexion with the traveling die, r, for the purpose of insuring the proper presentation of the blanks to the latter, and at the same time admitting of a proper cutting edge for the female die. 2d, The employment of a forming die, J, in connexion with a rotating or partially rotating die, r, arranged to insure, simultaneously with the process of swaging the blanks into the proper shaped links, the proper adjustment of the latter for interlocking of the same. 3d, The decreased diameter of the upper portion of the forming die, J, so as to insure the adhesion of the cap, cup, or link to it, and enable the said die to perform the double function of die and carrier, when said die, J, is used in connexion with the die, r, to operate conjointly. 4th, Constructing the die, r, with a rod, with or without shears or projections, and arranged as set forth. 5th, The clearer rod and collar, either or both, applied to the forming die, J, and arranged to operate in connexion with the die, r, and rod, as set forth. 6th, The clamps in connexion with the swage or clinching tool, or its equivalent, arranged to operate conjointly, as specified. 7th, The guide plate, in connexion with the swage or clinching tool, the former serving as a guide to the latter, and insuring its proper action. 8th, The swage or clinching tool, constructed as shown, to bend or clinch the arms of the links, and at the same time keep the arms of the uppermost link in proper position, so that the latter may readily receive the succeeding link.

227. WASHING MACHINE; S. E. Lanphear and O. D Barrett, Cleveland, Ohio.

Claim—Supporting the disc by its stem on the standard, as set forth.

228. COTTON-SPINNING MACHINERY; Evan Leigh, Manchester, England; patented in England, February 26, 1858.

Claim—1st, The construction of top rollers and spindles with the arrangement of one or more of the bosses loose revolving thereon. 2d, The application of a journal, or all kinds of shafting spindles, studs, or axles, having the bearing part of the shaft, spindle, or axle or stud larger in diameter than the part immediately outside the bearing. 3d, The rounding out or dishing the edges of the steps or bosses, in combination with the tapering of journals or axles, of all kinds, by which I obtain the action of capillary attraction, for the purpose set forth. 4th, The application of a top roller of a spinning machine to its spindle, in such a manner as to enable such top roller to rotate on the spindle, and to rock in a longitudinal direction, in order that it may properly adjust itself to the under roller, while the two may be in use.

229. AMALGAMATOR; Frank Maxson, San Francisco, California.

Claim—The use of the eccentric revolving pan, constructed and operated as described, in connexion with the amalgamated plate, as specified. Also, the arrangement of the shaft, projection pin, with the slotted piece, and wood, whereby a more or less eccentric motion is imparted to the pan, as described.

230. COMPOSITION OF EMERY FOR GRINDING AND POLISHING TOOLS; Thomas J. Mayall, Roxbury, Massachusetts.

Claim—My new compound for emery-sharpening and polishing tools, the same being made by combining 15 lbs. of emery, 1 lb. of india rubber or gutta percha, and 5 oz. of sulphur.

231. METALLIC SEALS FOR LETTERS, &c.; C. A. McEvoy, Richmond, Virginia.

Claim—The use together, in the manner described, of the metallic concave discs, having sharp points projecting from their circumferences, as set forth.

232. CULTIVATORS; Thomas McQuiston, Morning Sun, Ohio.

Claim—The described arrangement of the elevated axle, beam, brackets, and rods, constructed in the manner set forth.

233. CAR COUPLINGS; John H. Mears and George Cameron, Oshkosh, Wisconsin.

Claim—1st, The tongue, G, for retaining link, H, constructed and operating as described. 2d, The arrangement of yoke, lever, spring, and connecting rod, as described.

234. Mole Plough; Adam Miller, Mount Pleasant, Iowa.

Claim—The employment of the rod, in combination with the coulter provided with staples, and the mole provided with the hooks, for the purposes specified.

235. Mole Plough; John Morrison, De Witt, Illinois.

Claim—The draft chain, bar, loops, and the adjusting screw rods, or their equivalents, combined, arranged, and applied to the plough, as set forth.

236. Machine for Manufacturing Bonnet and Cap Fronts, &c; W. H. Morrison, Nottingham, England.

Claim—The application, in apparatus or machinery of the character referred to, of bars or gauges, operated to move simultaneously towards the lace or other fabric. Also, the adaptation of plates, operating in manner explained.

237. Cotton Gins; Enoch Osgood, Boston, Massachusetts.

Claim—1st, The rollers, plates, and bands, arranged as set forth. 2d, The combination and arrangement in a cotton gin or wool burring machine, of the clearer, rollers, angular plates, bands, slotted arms or bars, pinion, and wheel, in the manner described.

238. Cabinet Chair; Sewall Pearson, Boston, Massachusetts.

Claim—Arranging in a bureau, chair, or other piece of furniture, in combination with a perforated seat, and with a self-closing pot, a water tank, which forms the back for the seat, and which communicates with the pot by means of a spout.

239. Polishing Iron; George J. Prentiss, Fall River, Massachusetts.

Claim—The polishing cup, having two handles, arranged as described, or in any other manner substantially the same.

240. Trusses for Relieving Piles; Hiram M. Smith, Richmond, Virginia.

Claim—As improvements in the construction of anti-hemorrhoidal pads: 1st, The manner of sustaining such pads by means of springs passing from the pad to the front of the patient, and in a spiral form along the groin to a point over the hip joint, in combination with the plan of sustaining the instrument by flexible fastenings attached above the hip joints, thus making the instrument self-adjusting and enabling the patient to exercise in any position without inconvenience. 2d. The manner of balancing the instrument by means of flexible fastenings attached over the hip joints, no matter how the arms of the pad may be varied.

241. Tubular Connexion of Bridges; Joseph W. Sprague, Rochester, New York.

Claim—The described series of clutches, provided with bands, in combination with the tubular sections, for the purposes set forth.

242. Cocks; David H. Stickney, Cincinnati, Ohio.

Claim—The supplementary chamber and stationary stuffing-box, in combination with a hollow piston, having ingress apertures adapted to be placed on either side of the said stuffing-box, by the motion of the piston.

243. Bustles; A. J. Thompson, Malden, Massachusetts.

Claim—The combination of a spring bustle of a flat spring or springs, united at their ends, to form the perimeter of the bustle or its frame work, and spread or divided, to establish a base at their bearing surface or surfaces against the body of the wearer and spiral springs, of conical configuration, and arranged to form cross-ties to the flat springs with their bases resting against the base formed by the latter, and for action in concert with the latter, and unitedly.

244. Portable Crab for Mole Ploughs; Elijah Thorn, Selma, Ohio.

Claim—The arrangement of the frame, as constructed with the boxes, which are attached to the rear of the frame, and with the axle and wheels, the several parts being connected together and used, not only for elevating the machine, but for guiding its rear and changing its position.

245. Manufacture of Hoes; Eben C. Tuttle, Naugatuck, Connecticut.

Claim—The construction of a hoe, by securing the eye in the blade by two projecting swells or beads, constructed and fitted for use, as described.

246. Naval Architecture; Benjamin F. Wells, Georgetown, D. C.

Claim—Deriving the lines of vessels of all kinds and dimensions, from sections of a circular spindle of any dimensions or proportions, as described.

247. Carpet-stretcher; William Wheeler, West Poultney, Vermont.

Claim—The stretcher, when provided with the notch and the heel points, for the purpose set forth.

248. Horizontal Water-wheel; J. T. Wilder, Greensburgh, Indiana.

Claim—1st, Constructing a water-wheel with two sets of involute buckets, whose capacity shall be in the relative proportion to each other, as specified. 2d, The combination, with a wheel such as has been described, of a casing provided with two channels of different capacities and with two gates, arranged as described.

249. Thermostats; Charles A. Wilson, Cincinnati, Ohio.

Claim—A tubular thermostat, forming a part of the steam or other passage to be regulated and adapted by means of the unequal expansion of the metals of which it is composed, to close the said passage by lateral deflexion.

250. Bustles; George W. Yerby, City of New York.

Claim—The bustle, in which the waistband has a back piece and a corset, or part corset, in front, provided with one, two, or more sets of pockets, into which the springs of the bustle are inserted, constructed in the manner described.

251. Weeding-hoes; James M. Adams, Assignor to self and Alonzo Johnson, Canton, Massachusetts.

Claim—The arrangement of the two blades with the bifurcated handle, constructed in the manner set forth.

252. Preserve Cans; Benjamin L. Agnew, Assignor to G. P. Reed, Indiana, Pennsylvania.

Claim—The combination, in a preserve jar, of a deep outer flanch or rim, with a shallow inner flanch, in the manner described.

253. Rods of Window Blinds; John G. Baker, Assignor to self and Asa L. Carrier, Washington City, D. C.

Claim—The peculiar construction of thin metallic tubes, the two edges so forming the ears or rings, in combination with wire staples or rings, to connect wood slats for movable blinds.

254. BUSTLES; Barron Davis, Brooklyn, New York, Assignor to Osborn & Vincent, City of New York.

Claim—Attaching the hoops to the extension by fixed and immovable connexions, so that the hoops cannot be thrown forward or outward, when the hoops are connected to the band by means of the cross-bands, in combination with the back point or extension.

255. METHOD OF MAKING GAS FROM PEAT; J. Burrows Hyde, Assignor to Phebe Bamman, Newark, N. J.

Claim—1st, Exposing such peaty matter to thorough desiccation by artificial heat, and conveying it to the retort without permitting it to absorb moisture from the air. 2d, Granulating or powdering such peaty matter, distilling and cooling it in closed cases. 3d, Employing the heat evolved in cooling the carbonized material to aid in desiccating the peaty matter.

256. MACHINE FOR COVERING SADDLE-TREES; John Maclure, Assignor to self, Samuel E. Tompkins, and Samuel C. Northrup, Newark, New Jersey.

Claim—The employment of an elastic bed or cushion, in combination with the cover and seat, as described. Also, the arrangement and combination of the box, adjustable sliding bars, elastic cushion, seat, clamp, and pressing lever, as described.

257. CLOTHES FRAME; S. W. and J. F. Palmer, Assignors to S. W. Palmer, N. Palmer, and John Patty, Auburn, New York.

Claim—Hinging the arms of a clothes frame to the sliding hubs by means of the pins, which are supported by the open lugs, arranged in the manner described. Also, in combination with the shaft and its grooves, the sliding catch-ring with its spring and projection, for retaining the frame in its position. Also, in combination with the central post or shaft and sliding frame, the hoisting apparatus, consisting of the clutch-rings, with their springs, lever, and link.

258. FANCY LOOMS; Conrad Roder, Assignor to self and J. F. Iler, Ceralvo, Kentucky.

Claim—The combination and arrangement of the double catch-hooks, adjustable guide plate, the sash, with the lifting bar, in the manner described.

259. CLASP FOR SKELETON SKIRTS; Wm. Daniel Sloan, Assignor to A. B. Chapman, City of New York.

Claim—The clasp for uniting the tapes or galloons to the hoops in skeleton skirts, said clasp being formed with a narrow ribbed or V-shape back piece.

260. PADDLE-WHEEL; James Speers, West Manchester, Assignor to self, Alexander Postley, and John Webbe, Allegheny County, Pennsylvania.

Claim—The arrangement of the flanches, the arms with points, the braces, and floats, when used for the purpose of constructing a propeller.

261. BANJOS; Stephen F. Van Hagen, Assignor to George Kilbourne, Albany, New York.

Claim—The combination, in one instrument, of the banjo parchment-covered open body, with the neck and fretted finger-board of the guitar, the thumb-string of the banjo being added to the usual strings of the guitar. Also, the formation of the front part of the body of the instrument, of an acute, oval or lancet form, in the manner set forth.

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262. MOULDING PLOUGHS; B. F. Avery, Louisville, Kentucky.

Claim—The peculiar construction of the patterns of the short land-side, so that they may be drawn at opposite angles from each other, for the purpose and in the manner specified.

263. BRONZING MACHINE; G. H. Babcock, Westerly, Rhode Island.

Claim—1st, In combination with mechanism for conveying the sheet, the use of rubbing cylinder and brush, one or more of each, for the purposes and in the manner described. 2d, The use of one or more stationary rubbers, or their equivalents, for the purposes specified. 3d, The wires, or their equivalents, for freeing the brush from the powder. 4th, Constructing the gripper, in the manner described, whereby I obtain the advantages set forth. 5th, Enclosing the rubbing and brushing cylinders in a case, for the purpose of retaining the powder and preventing waste.

264. DITCHING MACHINES; J. W. Barcroft, Friendship, Virginia.

Claim—1st. The combination of a revolving wheel, having its buckets or scoops set tangentially with a stationary circular guard, and an adjustable scraper. 2d, Having the buckets or scoops hung on an axis at the centre of their length, and adjustable at both ends, as set forth. 3d, Providing sharp cutters, projecting at right angles from the centre of the scoop, as set forth.

265. SEWING MACHINES; Wm. T. Barnes, Buffalo, New York.

Claim—The arrangement of the threaded elastic looper, as constructed, with a receiving and transferring spring, when the two are secured on opposite sides of the needle, and operated to and from the needle by means of levers, connecting rods, and frames, combined as set forth.

266. COAL-SIFTERS; Mellen Battel, Albany, New York.

Claim—The stationary ploughs, and brushes, and ribbons, in combination with the horizontal revolving sieve, as set forth.

267. APPARATUS FOR OPERATING RUDDERS; C. F. E. Blaich, Elyria, Ohio.

Claim—The combination of the rudder, spiral ribs, and spirally grooved sliding tube, in the manner set forth.

268. METHOD OF ELEVATING WATER; C. C. Bomberger, West Carlisle, Pennsylvania.

Claim—The arrangement of the air-tight boxes, connected by the pipe, G, and communicating respectively with the pipes, A D, in connexion with the open vessel, tube, H, and the valves placed to the tube, E, and pipe, F, and operated automatically as shown.

269. MECHANISM FOR CONVERTING ROTARY INTO RECIPROCATING MOTION; W. N. Brown, City of New York.

Claim—The rock shaft having a hollow hub, in combination with the oblong ring and rotating cam, operating in the manner set forth.

270. FLOATING SAFETY CABIN; M. J. Butler, Nashville, Tennessee.

Claim—The arrangement of the detached boat-shaped cabin, gate propeller, jointed hinged straps, wedge, rudder, windlass, ordinary vessel, valve, passage, and stairs, in the manner set forth.

271. SURF LIFE-BOAT; M. M. Camp, New Haven, Connecticut.

Claim—1st, The combination of the water ballast chamber with the aperture and air-pipe, for the purpose of ballasting the boat when she enters the water, and of lightening it when she touches and reaches the shore. 2d, The combination of the valve with the ballast chamber and aperture. 3d, The combination of the floors, for the purpose of forming the air chamber beneath the working floor, and between the two floors. 4th, The combination of the divisions with the working floor, to form receptacles between said divisions and the sides of the boat.

272. CONSTRUCTION OF GLASS COFFINS; J. R. Cannon, New Albany, Indiana.

Claim—Constructing a coffin of glass, the body of which is provided with a groove, and the lid with a flanch and a pump, the lid being secured to the body by means of metallic bands.

273. MACHINES FOR BOLTING FLOUR, &c.; M. H. Collins, Chelsea, Massachusetts.

Claim—1st, A curved frame, in which are placed one or more bolting sieves, this frame being open at each end for the discharge of bran or other coarse material. 2d, The combination with the curved frame and sieves of a corrugated rubber, the frame and sieves having a vibrating motion in the path of a circle, while the rubber remains stationary. 3d, The arrangement of sieves of different sized meshes, and having the same vibrating motion on the circular vibrating frame, and in the relation shown to a fan-wheel, which causes a draft at the back of the machine.

274. SEWING MACHINES; C. O. Crosby, New Haven, Connecticut.

Claim—1st, The rotary bobbin case, armed with the inclined loop spreader, and supporting on a pin, in its centre, the bobbin, which holds one of the threads, in combination with the loop detainer. 2d, The method of detaining the loop of the needle-thread after the loop has passed the full diameter of the bobbin case, by the projection and inclined plane terminating in a point on the buffer. 3d, The frame or form, composed of the curved bar, o, bar, R, and foot, in combination with the bolt, elbow-shaped lever (carrying the pieces, g), and friction cap, arranged to feed the material.

275. CENTREING MACHINES; James Cumming, Boston, Massachusetts.

Claim—1st, The arrangement of the notched interlocking slides, right and left screws, pinions, shaft, bed-plate, and upright drill, operating in the manner described. 2d, The combination of the drill arbor, hollow swivel oiling cap, independently rising and falling rod, and disc, attached in the manner described.

276. WASHING MACHINE; R. C. Cyphers, Milledgeville, Georgia.

Claim—1st, The arrangement of the elastic suspended concave, with slats pivoted to elastic strips, in combination with the jointed spring rubber, as described. 2d, In combination with the jointed spring rubber, the employment of a flexible band or rope, for the purpose of securing the clothes to the rubber. 3d, The arrangement of the central shaft, in combination with the elastic suspended concave and grooves.

277. HARVESTERS; Horace L. Emery, Albany, New York.

Claim—1st, Combining with the cutter bar an adjustable arm or lever, provided with a roller, or other means of sliding easily upon the ground, for the purpose of sustaining the cutter bar at any required distance from the ground, or allowing it to rest upon the ground at pleasure. 2d, Placing the said arm directly in rear of the shoe, in order that it may be prevented by said shoe from clogging. 3d, Connecting said arm by a rod along the back of the cutter bar with a lever near the frame of the machine, so that the attendant may elevate and depress the cutter bar at pleasure.

278. SEED PLANTERS; George M. Evans, Pittsburgh, Pennsylvania.

Claim—The combination and arrangement of the seed drums, elevators on the belt, with the compartments of the hopper, the cranks, the connecting rods, the ratchet wheels, and the wheel, as described.

279. COFFEE-POTS; H. B. Fay, City of New York.

Claim—The arrangement of the tube, in combination with the adjustable double-strainer, that is arranged in a pot between the spout and the liquid, as described.

280. STUDS AND SLEEVE-FASTENERS; Felix A. Finn, City of New York.

Claim—The swivel bar and arm, arranged as specified. Also, in combination therewith, the dovetail stud, to confine the front end of the arm when closed upon it. Also, the projecting screw, against which the spring acts. Also, in combination with the above devices, the spring, constructed as set forth.

281. AUTOMATIC FAN; Frederick O. Degener, City of New York.

Claim—The arrangement and combination of a rotary fan-blower, with the hollow vibrating or distributing fan, for the purpose of producing a current of air and causing it to be distributed, as specified.

282. VALVES FOR STOVES, FURNACES, &c.; B. Wells Dunklee, Boston, Massachusetts.

Claim—The side plates, projecting from and connected with the hoe valve, as related to each other, and in respect to the openings and flue, in manner described.

283. PRESERVE CANS; Wm. Fridley and Frederick Cornman, Carlisle, Pennsylvania.

Claim—The employment of a perforated cover, in combination with the gasket and mouth, so that the gasket constitutes virtually a portion of the cover of, and an index to, the condition of the contents of the vessel.

284. MACHINE FOR CLEANING AND OPENING FLOCK; W. C. Geer, Rockville, Connecticut.

Claim—The employment or use of a revolving cone or cylinder, provided with toothed lugs, and placed within a correspondingly shaped toothed shell, in combination with the toothed cylinder, concave, and fan, arranged as set forth.

285. IMPLEMENT FOR BORING EARTH; Daniel Gordon, Evansville, Indiana.

Claim—Arranging the blades on the convex surface of the bottom of the auger, and extending the cut beyond the periphery. Also, arranging the valves in the concave sides of the bottom of the auger, as set forth.

286. MACHINERY FOR CLEANING COTTON; Daniel Hess, West Union, Iowa.

Claim—1st, The curved metallic division, in combination with the front rollers and the bolting cloth, in the manner set forth. 2d, The combination of the fan and case with the back rollers and the bolting cloth, for the purpose of cleansing the cloth from fibres of cotton.

287. PUMPS; Silas Hewitt, Seneca Falls, New York.

Claim—The plunger or bucket, constructed in the manner set forth.

288. DITCHING AND GRADING MACHINES; Isaac Hoskins, Wilmington, Ohio.

Claim—Making the side wheel adjustable so as to raise and lower the side of the frame, to level or adjust it as desired. Also, a bell made of bars, with projections or flanches at each end, arranged to travel under cleats on the sides of the frame or trough.

289. DOOR LATCH AND LOCK; Anthony Iske and Jacob Teufel, Lancaster, Pennsylvania.

Claim—The arrangement and combination of the curved swivel lever, bolt, with its peg and projecting end, to answer both for turning, pulling, and pushing together, with the revolving lever for operating the lock.

290. FURNACES FOR STEAM BOILERS; Edward H. Jones, Albany, and Robert Stevenson, Schenectady, N. Y.

Claim—The arrangement of the hopper-shaped grate-box, so constructed as to be adjustable in height, combined with the grates, having means attached for rocking or agitating them, in their relation to each other and to the boiler fire-box, in the manner set forth.

291. MOLE PLOUGH; S. F. Jones, St. Paul, Indiana.

Claim—1st, The employment of the ball, not generally, but when said ball is secured in such a manner upon the top of the rear of the mole, that it will revolve when the mole is in motion, for the purpose of arching the top of the drain and closing the opening of the coulter. 2d, The combination of the nose, mole, ball, rod, and wheel, when the same are used for the purpose of forming and arching the drain and closing the opening of the coulter.

292. MOVING TREAD POWER; Louis Koch, City of New York.

Claim—1st, The described mechanism, or its equivalent, when operated by the feet of man or animal, in stepping on the ends of bands or cords during the act of walking. 2d, Using the weight of man or animal in stepping on bands, or their equivalent, as a cause of resistance against the propelling of the machine, and giving motion by the walking of said man or animal to said mechanism, or its equivalent, independently of the motion of the wheels on which the whole mechanism is supported.

293. COTTON PRESSES; Charles N. Lovejoy, Columbia, South Carolina.

Claim—The guides for guiding the chains upon fusee wheels, and the follower, block, and windlasses, arranged in the manner as described, when combined with the cotton box and its operative parts, in the manner described.

294. SKIRT-SUPPORTERS; John McNeven, Brooklyn, New York.

Claim—The dress-supporter, consisting of a hoop and stiffeners branching off from said hoop, the wristband, and tapes, arranged and applied to the body in the manner described.

295. DOORS FOR IRON SAFES; L. H. Miller, Baltimore, Maryland.

Claim—The combination of the tongue, grooved flanches, V-shaped mouldings, and V-shaped grooves, in the construction of a fire-proof safe or bank vault, in the manner described.

296. APPARATUS FOR GENERATING STEAM; Thomas Moore, Minneapolis, Minnesota.

Claim—The employment, in combination with a steam engine, or other apparatus in which steam is used, and the boiler which supplies it, of a system or arrangement of one or more condensers and heaters, with connecting pipes and a tank, whereby the exhaust steam, after passing along a pipe running through the boiler itself, is condensed by delivering up its remaining latent heat to water, which, after having been previously condensed in the same manner, is on its way back to the boiler, and whereby the water obtained by the condensation of the exhaust steam is heated on its way back to the boiler, and partly converted into steam again by the combined agencies of the latent heat it absorbs from the escaping steam, and by the heat it absorbs from the escaping waste production of combustion, as described.

297. WIND-MILLS; James W. Neff, Sacramento, California.

Claim—The arrangement of the sails, arms, or spokes, and hub, and placing them in rear of the spiral spring and flanch, and connecting the flanch with sails by rods, as described.

298. COFFEE-POTS; George Neilson, Boston, Massachusetts.

Claim—The reversible cafetiere, as composed of boiler, the filtering biggin, the foraminous cup or strainer, and the condenser or coffee-pot, having a spout and cap, arranged in manner explained. Also, the combination of the air and tell-tale pipe with the boiling vessel, the condensing vessel, the biggin, and the strainer or cup.

299. NAIL MACHINES; Adrian V. B. Orr, Lancaster, Pennsylvania.

Claim—1st, Combining, in a single pair of dies, constructed as described, the operations of cutting, pressing, and gripping the nails or spike. 2d, The slide point, operating in combination with the slide, arranged as specified.

300. CAR BRAKES; George F. Outten, Norfolk, Virginia.

Claim—The combination and arrangement of slide, pawl, spring, a, ratchet wheels, and chain, levers, and spring, h, operating automatically or by hand, as may be desired.

301. APPARATUS FOR RAISING WATER FROM WELLS, &c.; Elhanan Puffer, Oxford, New York.

Claim—Producing and controlling the movements of the windlass roller upon and with its actuating shaft, in such a manner as to prevent the necessity of ever imparting a reverse rotary movement to the windlass shaft whilst operating said apparatus, and by means substantially the same as those described. Also, combining the valve which closes the discharging aperture in the bottom of the bucket, with the inner end of the lever, which is pivoted to the after edge of the mouth of said bucket, when a rod, or the equivalent of the same, is so situated within the curb as to be taken hold of by the hook-shaped outer end of said lever, just before the bucket reaches its highest position, for the purpose of causing the further upward movement of said bucket to throw forward its bottom and discharge its contents.

302. SEWING MACHINES; T. J. W. Robertson, City of New York.

Claim—The arrangement and combination of the carrier, spring plug, and vibrating arm, as described.

303. CHURN-DASHER; Alfred Rose, Penn Yan, New York.

Claim—The churn-dasher, when made in the manner substantially as set forth,

304. DISENGAGING HOOK; Albert W. Roberts, Hartford, Connecticut.

Claim—A hook, consisting of a hook link with bearer on its side, in combination with the jointed ring, lever, crank pin, and collar, as described.

305. MILLS FOR CRUSHING SUGAR-CANE; F. M. Robinson, Conneautville, Pennsylvania.

Claim—The combination of the flanched journal-boxes with the flanched sockets, in connexion with the flanches of the above parts.

306. REEFING FORE-AND-AFT SAILS; Samuel Samuels, Brooklyn, New York.

Claim—Supporting the rolling boom in two bearings, one of which is in a truss connected with the mast by a hoop or its equivalent, and the other in a ring, which is held by the lift and braces. Also, the combination, with the rolling boom, of the gypsy-purchase, applied as described.

307. SEWING MACHINES; Irwin B. Sawyer and T. Alsop, Springfield, Illinois.

Claim—The use of the hook, formed and moving as described, combined with the shuttle and needle.

308. PIANO-FORTE ACTION; Thomas S. Seabury, Stony Brook, New York, Assignor to R. B. Gorsuch, City of New York.

Claim—1st, Pivoting the hammer-butt to a post, or its equivalent, carried by its respective key, for the purpose of enabling it to be withdrawn from the instrument along with the key. 2d, The suspended jack or fly-lever, attached to the hammer-butt, and provided with a notch, operating in combination with stationary rail. 3d, The arrangement of the regulating screw in the suspended jack or fly-lever, in combination with the inclined plane on the post erected upon the key, to carry the hammer—but I wish to be understood as not claiming, generally, either the placing of the regulating screw in the jack, or the employment of an inclined plane or wedge, to act in combination with an inclined or wedge-like surface. 4th, The check, applied to the bottom of the key, and operating in combination with the suspended jack or fly-lever.

309. CARRIAGES; Isaac M. Singer, City of New York.

Claim—The arrangement, in the main body of the carriage, of the low seats, in combination with the elevated seats, arranged in manner described. Also, in combination with the back, depressed and elevated seats, as described, the arrangement of the hinged partition to answer the three-fold purpose of a step to get to the elevated back seats, and back to the middle depressed seat, and to separate the feet of persons sitting on the elevated seats from the persons sitting on the depressed seats. Also, in combination with the front elevated seats, as described, the arrangement of hinged step leading to the elevated seats, together with its dirt-flap, for the three-fold purpose of a step to the elevated seats, a dirt protector, and of a seat in case of necessity. Also, the arrangement of the boot for baggage in the space between the bottom and the front elevated seats, with doors at the sides, thus placing the weight below, and concentrating it on the front axle. Also, the combination with the main body of the carriage, the placing the coupe at the rear thereof, and communicating therewith by a door-way through the back. Also, depressing the coupe at the back of the main body, that the bottom of both may extend below and leave the required open space for the rear axle and its connexions; and that the top of the coupe may form a foot-board to the seats, at the back edge of the main body. Also, in combination with the coupe, the open spaces under the back elevated seats of the main body opening into the coupe.

310. THRUST-BEARINGS FOR ROTARY SHAFTS; George A. Stone, Roxbury, Massachusetts.

Claim—1st, The combination of these four things, namely, a collar or collars on the shaft; washers provided with grooves on their faces, extending from their outer to their inner edges, as described; a reservoir of oil or other lubricating material; and a pillow block or stationary resistance. 2d, In combination with washers provided with grooves on their faces, a reservoir of lubricating material, a pillow block, or its equivalent, and a collar on a shaft, all as specified in my first claim, I claim grooves extending from face to face of the washers, in the manner described.

311. GRAIN SEPARATORS; F. Swift, Hudson, Michigan.

Claim—The employment or use of a supplemental shoe, C, placed within the shoe, B, provided with screws, and having an independent longitudinal shake movement given it, while the shoe, B, with its screws, has the usual lateral shake movement imparted to it.

312. KEYS FOR LOCKS; Peter Van Antwerp, City of New York.

Claim—Constructing the stems of keys with a hole near the end, instead of the usual permanent bow or ring handle, and to be fitted loosely to the usual ring for connecting a series of keys, and in such manner as described, that said connecting ring shall answer the further purpose of the usual bow or fixed ring for turning the keys when inserted in the lock.

313. SPRING BED; John L. Whipple, Detroit, Michigan.

Claim—The general arrangement of the seat, spring, and the strap, in the form described, and combined for the purpose in the position as set forth.

314. FIELD FENCES; John L. Wentworth, Spread Eagle, Pennsylvania.

Claim—Constructing each section of a fence of the two end posts, upper and lower longitudinal rails, any suitable number of intermediate rails, E and F, and the vertical bar, arranged in respect to, and adapted to each other, as set forth.

315. BREECH-LOADING FIRE ARMS; Franklin Wesson and Nathan S. Harrington, Worcester, Massachusetts.

Claim—1st, The combination of the mechanism for locking and unlocking the barrel, and the arrangement of the trigger, as described. 2d, The combination, with the locking and unlocking mechanism, of the spring, arranged as described, for elevating the breech. 3d, In combination with the barrel, the wedge-shaped recess in the recoil plate, arranged as described.

316. PORTABLE SHELVES; J. S. Voorhies, Catlettsburg, Kentucky.

Claim—Constructing portable box-shelving for stoves, book-cases, and all similar purposes, in the manner described.

317. SHIRT-STUDS; Dutee Wilcox, Providence, Rhode Island.

Claim—The described mode of making a shirt-stud or button, viz: of the two parts or plates, and the two hooks or curved holders, arranged in the manner described.

318. CANNON; Joseph Adams, Assignor to self and B. Barker, Cleveland, Ohio.

Claim—The use and application of a piston for the purpose of loading, cleaning, and cooling a cannon, the stem or end of which passes through the breech or rear end of the gun, and is attached to a head or metallic piston, the circumference of which is equal to that of the bore of the cannon, and is made to fit the same exactly, and which piston-head, when drawn back, rests upon the main shoulder or substance of the breech at the point where the rod connects therewith, and is of sufficient length to cover and serve as a valve to close the lateral opening at the breech end of the cannon, through which water is admitted to fill the bore of the

gun when said piston is forced forward towards the muzzle, and which piston plays forward and backward, the entire length of the bore of the gun, so as to protrude sufficiently at the muzzle when forced forward, thus carrying out any substance of the exhausted cartridge after firing, and to which piston-head or bulb the new cartridge is attached and drawn back to the breech or butt of the gun by the force applied to said rod, and in which condition the gun is loaded and ready to be again discharged. Also, the construction and employment of a lateral opening from the main chamber or bore of the gun, either passing through the breech-pin or otherwise, at or near the rear end thereof, and where the same will be closed and covered by the piston-head, when the same is fully drawn back into (or by means of a tube or pipe connecting with a water-sack or vessel), and by means of which arrangement water is admitted and drawn into the gun by the same force which carries the piston forward to receive the charge at the muzzle, and is returned to the vessel again by the same force which carries in the charge, thus washing and cooling the gun at every discharge, without any other movement than that necessarily employed in the act of loading alone.

319. Mode of Feeding-in Fuel to the Fire-boxes of Cooking Stoves; M. C. Cronk, Assignor to self, William Boynton, Jr., and Albert H. Goss, Auburn, New York.

Claim—1st, In combination with the stationary upper fire-box, a rocking or swinging fire-box underneath it, having a flanch or cut-off connected thereto. 2d, In combination with the rocking or swinging fire-box and cut-off, a rising and falling grate. 3d, In combination with the rocking or swinging fire-box and rising and falling grate, a single rod or shaft, with its cams for operating both.

320. Stoves; L. W. C. Farrington, Lowell, Assignor to Tuttle & Mudge, Boston, Massachusetts.

Claim—A parlor stove, having an oven, which is opened by raising the top, in the manner set forth.

321. Razor-strops; Charles Younglove Haynes, Assignor to C. Y. Haynes & Co., Philadelphia, Pennsylvania.

Claim—The strop, constructed in the manner described.

322. Amalgamator; W. H. Howland, Assignor to self and John O. Hanson, San Francisco, California.

Claim—The combination of a pair of grinding cones, revolving in different directions, with a horizontally-oscillating chambered dish, as described.

323. Watches; Joseph Ives, Bristol, Connecticut.

Claim—1st, The combination of the spring, lever, and cam, in the manner described. 2d, The substitution of ribbed, corrugated, planished or unplanished tin plate for running gear, &c. (for other metal), when used in combination with the rolling pinion, as described. 3d, Making a crown-wheel with rollers instead of teeth, to prevent slide and friction upon the verge or pallet, in the manner described.

324. Composition for Mixing with Paints; George W. Slagle, Assignor to self and O. A. Dailey, Washington City, D. C.

Claim—Making melaniline oil, or a substitute for linseed oil, by mixing together linseed oil, or other vegetable oil possessing similar qualities, water, and sal-soda, or other similar suitable alkali, in the manner set forth.

Extensions.

1. Barrel Machinery; Wm. Trapp, Jr., Dryden, New York; re-issued October 1, 1845; re-re-issued March 10, 1849; extended October 4, 1859.

Claim—1st, The combination of the slide rest guided in the manner set forth, with the tool for turning off the cask. 2d, The apparatus for chamfering, and howelling, and crozing—that is to say, the combination of the cylinder, open at both ends, so that both ends of the cask can be worked off without changing, with the ring-chucks for fastening the cask into the cylinder, and with the tools as described, for chamfering and howelling. 3d, The crozing-tool with the changeable face-plate. 4th, The combination of the stock, cutter, adjustable and gauge plate, constituting the tool for turning and smoothing the outside of the cask. 5th, The peculiar construction of the tool for howelling the cask, as described. 6th, The peculiar construction of the tool for chamfering the ends of the cask, as described. 7th, The mode of edging and jointing bilge staves, for making barrels and other bilge work, by the employment of a swing frame having a concave or convex bed in or against which the staves are sprung and secured to the required bilge, in combination with the revolving edging-saw and reciprocating straight-jointer, or either, whether the said swing frame for confining the stave in its bent position, and conveying it to the edging-saw and straight-jointer, be constructed in the manner set forth, or in any other manner that may be substantially the same.

2. Ruling Machines; Lewis Edwards, Norwich, Connecticut; patented October 9, 1845; extended October 11, 1859.

Claim—Causing the pens to be raised by the edge of the paper in its passage through the machine, thus causing each sheet to determine the length of its own lines.

3. Cultivator Teeth; David B. Rogers, Pittsburgh, Pennsylvania; patented Nov. 1, 1845; re-issued Sept. 20, 1859; extended October 25, 1859.

Claim—Making the shank or upper part of cultivator teeth of thin plate steel, U-shaped or curved round in front, substantially as described, for the purpose of securing the necessary strength to permit the tooth to be made entire, shank and blade, of a single piece of metal, and also enabling the tooth to be secured in its place in the band by means of a wedge driven into the cavity of the shank.

Additional Improvements.

1. Corn Planters; Alexander, William, and James Campbell, Harrison, Ohio; patented June 28, 1859; additional dated October 4, 1859.

Claim—1st, The described arrangement of the weighted valve, rod, tappet, wheel, slides, and tube, for the purpose set forth. 2d, In the described combination with a cam wheel, crank shaft, rod, and rocking lever, we claim the inverted arch yoke, constructed as set forth.

2. Tobacco Presses; Wm. R. Musser and J. Coleman, Lynchburg, Virginia; patented February 2, 1858; additional dated October 4, 1859.

Claim—1st, The top plate of the press in connexion with the bottom plate of said press, used for retaining pressure and forming the bed of the main truck. 2d, The groove nuts for raising and lowering the top plate of the press, without taking it from the bars.

3. ATTACHING THILLS TO VEHICLES; Douglas Bly, Rochester, New York; patented April 12, 1859; additional dated October 11, 1859.

Claim—Combining with the hook a collar, having a reverse hook or lip corresponding with the point to form an eye therewith, together with the screw shank and binding nut, as specified.

4. CURTAIN FIXTURES; Joseph F. Hall, Bangor, Maine; patented March 9, 1858; additional dated October 25, 1859.

Claim—The application of the lever, as explained, in combination with the cord and tassel, with the pulley or eye in the end of the tassel, as described.

RE-ISSUES.

1. FLOUR-BOLTS; James M. Clark, Philadelphia, Pennsylvania; patented July 26, 1859; re-issued October 4, 1859.

Claim—1st, The slide valve or valves, arranged and operating with the apertures in the sides of the bolting chest, so that either of the apertures can be opened or closed, or both closed when required, for the purpose of turning the material as desired in either of these directions. 2d, In combination with these valves, the concave and scrapers upon the bolt, arranged as set forth.

2. MACHINES FOR BURNISHING METALS; Jeremiah Stever, Bristol, Connecticut; patented May 1, 1855; re-issued October 11, 1859.

Claim—The burnishing of silver-plated and other metallic ware, such as spoons, knives, and forks, or other similar articles which have a concave, convex, or other bevel surface, by an organized machine, requiring no other attention than being kept in proper order, adjusted to suit the article about being burnished, set in motion, and having the articles properly introduced to it successively, in the manner set forth.

3. FURNACE FOR SMELTING IRON; Squire M. Fales, Baltimore, Maryland; patented February 8, 1859; re-issued October 18, 1859.

Claim—1st, The combination, with the cone of a furnace, of one or more arched recesses or chambers, A A, as set forth. 2d, The combination of the opening with the crown of the arch, A, as set forth. 3d, The combination with the arch recess, A, opening, in the crown of the same, of a movable tymp, to be applied to the outer ends of the arched recesses or chambers instead of the permanent tymp now in use, which movable tymp is kept in place by a cross-bar that can be removed at pleasure.

[This invention consists in enlarging the furnace below the base of the stack, so that the blast has a chance to circulate laterally before it passes up into the stack. Enlarging the furnace at its base also allows of vertical flux passages being provided in this character of furnace; and likewise of removable tuyeres, which allow ready access to the interior of the furnace, being used, and renders an ordinary stack furnace capable of melting old railroad bars, &c., as well as all kinds of ores, and reducing the same to the most profitable condition. By circulating the blast, it has been found that very important results are obtained.]

4. COFFEE-POTS; Charles B. Waite and Joseph W. Sener, Fredericksburg, Virginia; patented April 22, 1856; re-issued August 10, 1858; re-re-issued October 18, 1859.

Claim—The employment, in a condensing boiler, in which the water is impregnated with the aroma of the coffee, or other articles under treatment, of a siphon, or equivalent self-acting device, for the discharge of the contents of the condenser into the body of the boiler.

5. CALENDAR CLOCK; Holly Skinner, Huron, Ohio; patented March 2, 1858; re-issued October 18, 1859.

Claim—1st, The extra movable tooth and leap-year wheel, applied to or controlled by the year-wheel, to operate in the manner described, for the purpose of regulating the effective length of the tooth which represents the month of February. 2d, The arrangement of the month-wheel, its attached pinion and pin, the rack-bar and its pawl, the spring, or its equivalent, the lever and its stud, or their equivalents, the catch, or its equivalent, and the stop, the whole being applied to operate upon, and be controlled by, the year-wheel of a calendar movement. 3d, Arranging the month-wheel in such a manner that the same, at the end of each month, returns to its original position by the action of a spring, or its equivalent, gathered up or strained by the action of the clock-work, in the manner described.

6. CONSTRUCTION OF CYLINDERS AND PISTONS FOR PUMPS AND STEAM ENGINES; Wallace Wells, City of N. York; patented October 12, 1858; re-issued October 18, 1859.

Claim—The combination of the cylinder, open at both ends, with three pistons and their connexions, arranged as set forth.

7. LEATHER FINISHING MACHINES; Charles, T. F., and John W. Weston, Salem, Massachusetts; patented September 25, 1855; re-issued October 18, 1859.

Claim—1st, In machines for finishing leather, the employment of a soft elastic bed. 2d, The combination of an elastic bed or tool, both constructed and operating together to produce the desired effect upon the leather. 3d, In combination with the soft elastic bed and elastic finishing tool, the cord secured to the tool-stock, for the purpose of keeping the tool clear of the leather during its retrograde movement over the bed.

8. CLAPBOARD MACHINE; Aretus A. Wilder, Detroit, Michigan; patented October 30, 1855; re-issued October 18, 1859.

Claim—Re-sawing and bringing plank to an equal width at the same time. Also, the flanch rollers, with their springs, or equivalents, in combination with the adjustable back rest, for the purposes described.

9. JOURNAL-BOXES FOR RAILROAD CARS; S. W. Hoffman and Adam J. Frederick, Assignees (through mesne-assignment) of Robert McWilliams, Philadelphia, Pennsylvania; patented July 19, 1859; re-issued October 25, 1859.

Claim—1st, The upper half of the box with its socket formed by the flanch, in combination with the lower half of the box, when the two halves are arranged substantially as set forth, so that on adjusting the lower half to its place, it may assume the position shown in fig. 1, and so that when adjusted, the end of the oil chamber shall be close to the axle, for the purpose specified. 2d, The self-adjusting leather-packing and the metal plate, when both are dependent upon the lower half of the box for their proper position within the other half, and when they are otherwise arranged in respect to the upper and lower halves, as set forth.

10. HARVESTERS; W. S. Stetson, Baltimore, Maryland; patented April 5, 1859; re-issued October 25, 1859.

Claim—1st, In combination with a main frame, supported upon two carriage wheels, which frame bears the shaft and main cog-wheel, a second frame hinged to and vibrating about said shaft, so that the crank shaft on said second frame shall always be in a radial line to the main cog-wheel, however much said second frame

may vibrate on the main frame. 2d, Supporting the crank shaft upon a vibrating frame, intermediate between the cutter bar or its shoe, and the main frame, when said main frame bears the main cog-wheel, and said intermediate frame vibrates or turns about an axis parallel to the axis of the driving or carriage wheels.

11. Harvesters; W. S. Stetson, Baltimore, Maryland; patented April 5, 1859; re-issued October 25, 1859.

Claim—1st, The main frame which bears the pinion, and has its vibratory motions up and down independent of the motions of the platform and pole, in combination with the vibrating rod intermediate betweeen the said main frame and cutter bar. 2d, Combining the adjusting lever with the platform and main frame, in the manner set forth. 3d, Giving to the main frame which bears the driving pinion, a back and forth motion upon the axle-tree.

12. Harvesters; W. S. Stetson, Baltimore, Maryland; patented April 5, 1859; re-issued October 25, 1859.

Claim—The combination of the shoe with the vibrating frame, by means of axis at the rear end of said frame. Also, horsing or supporting the knife-bar in a position at right angles, or nearly so, to the carriage axle by two movements, as set forth.

Designs.

1. Box Stove; E. J. Cridge, Troy, New York; dated October 4, 1859.
2. Arms of Sewing Machines; James S. McCurdy, Brooklyn, New York, Assignor to J. M. Myers, City of New York; dated October 4, 1859.
3. Stoves; Garrettson Smith and H. Brown, Philadelphia, Pennsylvania, Assignors to Hayward, Bartlett & Co., Baltimore, Maryland; dated October 4, 1859.
4. Clock-case Front; Roswell Kimberly, Ansonia, Connecticut; dated October 11, 1859.
5. Trade Mark; James H. McLean, St. Louis, Missouri; dated October 11, 1859.
6. Ornamenting Sewing Machines; Wm. Newton Brown, City of New York; dated October 25, 1859.
7. Cooking Stoves; Andrew John Gallagher, Philadelphia, Pennsylvania; dated October 25, 1859.
8. Parlor Stoves; C. Harris and Paul W. Zoinier, Cincinnati, Ohio; dated October 25, 1859.
9. Floor Cloths; Jeremiah Meger, City of New York, Assignor to A. Sampson, Manchester, New Hampshire; dated October 25, 1859.
10. Cooking Stoves; Thomas H. Wood, John E. Roberts, and Henry S. Hubbell, Utica, New York; dated October 25, 1859.
11. Ornamenting Bottles; L. Q. C. Wishart, Philadelphia, Pennsylvania; dated October 25, 1859.

MECHANICS, PHYSICS, AND CHEMISTRY.

Specification of the Patent granted to Sigismond Leoni *for Improvements in the Manufacture of Useful and Ornamental Articles, Surfaces, and Works, Parts of Articles, and Parts of Machinery or Apparatus, from Talc and other Silicates of Magnesia, and from the same combined with other Substances.*—Dated March 21, 1859.*

For this purpose, according to my invention, the talc, steatite, or other silicate of magnesia, is first reduced to powder, and either alone or with the addition of glass, felspar, lime, or alumina, is pressed or forced in a more or less moist or wholly or partially plastic state, into moulds of the desired form or configuration, and, after being removed from the moulds, is baked, burnt, or fired to the requisite hardness. Metallic salts or oxides, carbon, or other coloring agent may be employed, if desired, for imparting color, or for staining. Even in those instances, however, in which I combine with the talc or other silicate of magnesia, glass, lime, felspar, or alumina, I employ only a small proportion of these four last-named substances, so that the silicate of magnesia may be said in all cases to form the main staple of the material treated, according to these my present improvements.

In carrying my invention into effect, the coloring or staining agents which I use, are, by preference, similar to those employed for coloring or staining porcelain, and may be applied by mixing them with the material before pressing it in the moulds, or otherwise, as desirable; or, of course, when preferred, coloring and staining agents may be wholly dispensed with, and the material allowed to retain its original hue. For the baking, burning, or firing, the kilns I use are similar to

* From the Repertory of Patent Inventions, Nov., 1859.

those adopted by porcelain manufacturers, and articles manufactured according to my invention may be enameled, glazed, or polished, by the means ordinarily employed for such purpose in respect of porcelain ware.

My invention is applicable to the manufacture of knife handles, spindle steps, bearings, toilette furniture, decorative mouldings, and various other articles, surfaces, and works, and parts of articles, and parts of machinery or apparatus, in which strength, hardness, and durability, and resistance to heat, friction, corrosion, or oxydation, &c., &c., are desirable qualities.

Claim, manufacturing articles, surfaces, and works, parts of articles, and parts of machinery or apparatus, from talc or other silicates of magnesia, alone or combined with other substances, in the manner hereinbefore described.

For the Journal of the Franklin Institute.

Particulars of the Steamer Alabama.

Hull built by Samuel Sneden. Machinery by Morgan Iron Works, New York. Owners, I. L. Day, and others.

Hull.—			
Length on deck,	235	feet.	
" between perpendiculars,	225	"	
Breadth of beam, molded,	32	"	2 inches.
Depth of hold to spar deck,	9	"	
Frames—molded, 3½ ins.—sided, 5-16—apart at centres, 17 ins. Shape ⅂ ⅂; width of flanches, 3½ ins.; thickness of plates, 5-16 to ½-inch.			
Cross floors—⅂ 15 ins. high by 5-16 in. thick. Diameter of rivets, ⅜ in.—apart, 2¼ ins. single riveted.			
Draft of water, forward and aft, loaded,	4	"	
Tonnage, . 656.			
Area of immersed section at above draft, 115 sq. ft.			
Engines.—Vertical beam.			
Diameter of cylinder,			50 inches.
Length of stroke,	10	feet.	
Maximum pressure of steam, 25 lbs.			
Cut-off—one-half.			
Boilers.—One—Return flue.			
Length of boiler,	30	feet.	
Breadth " at furnace, 12 ft., at shell, diameter,	10	"	9 inches.
Height " exclusive of steam chimney,	10	"	9 "
Number of furnaces, 3.			
Breadth "	3	"	7 "
Length of grate bars,	7	"	
Number of flues, above, 6 of 18 inches, and 6 of			9 "
Number of flues, below, 2 of 10 inches, and 8 of			15 "
Length of flues, above,	26	"	
Length of flues, below,	17	"	5 "
Diameter of smoke pipe,	4	"	2 "
Height "	30	"	
Paddle Wheels.—			
Diameter, over boards,	29	feet	6 inches.
Length of blades,	8	"	
Depth "			24 "
Number " 26.			

Remarks.—One independent steam, fire, and bilge pump. Four bulkheads. Saloon on main deck and saloon cabin above. Date of trial, October, 1859.

C. H. H.

For the Journal of the Franklin Institute.

Particulars of the U. S. Steam Sloop Narragansett.

Hull built by U. S. Government at Charlestown Navy Yard. Machinery by Boston Locomotive Works.

Hull.—

Length for tonnage,	188 feet 6 inches.
" on deck, from knighthead to taffrail,	208 "
" deep load water line,	186 " 6 "
Breadth of beam at midship section, extreme,	31 " 6 "
Depth of hold,	14 " 1 "
" " to berth deck, (to under side of berth deck beams,)	5 " 11 "
Length of engine and boiler space,	49 "
Shaft, above base line,	5 " 4 "
Draft of water at deep load line,	10 "
Tonnage, carpenter's measurement,	930 tons.
Area of immersed section at load draft,	252 sq. ft.
Displacement at load draft,	1043·06 tons.
Contents of bunkers in tons of coal,	193 tons.
Masts and rig—3 masts and bark rigged.	

Engines.—Two—Horizontal—Back action.

Diameter of cylinder,	48 inches.
Length of stroke,	2 feet 4 "
Diameter of shaft, propeller,	$9\frac{3}{4}$ "
" " crank (in journals),	$10\frac{3}{4}$ "
Maximum pressure of steam in pounds,	20 lbs.
Cut-off—adjustable slide.	
Maximum revolutions per minute,	80.
Weight of engines,	80 tons = 179,200 lbs.
Length " in ship, fore and aft,	13 " 8 "
" " athwart ships,	15 " 4 "

Boilers —Martin's Vertical tubular.

Length of boilers,	10 " 2 "
Breadth "	18 " 5 "
Height " exclusive of steam drum,	10 " 6 "
" " inclusive "	11 " 6 "
Number of furnaces in all,	11.
Breadth "	36 "
Length of grate bars,	6 "
Number of tubes (brass),	3190.
External diameter of tubes,	2 "
Length of tubes, extreme,	32 "
Heating surface,	5945·7 sq. ft.
Grate surface,	200 sq. ft.
Diameter of smoke pipe,	6 "
Height " above grates,	50 "
Description of coal,	Anthracite.
Draft,	a screw fan.

Screw.—

Diameter of screw,	9 feet 6 inches.
Length "	$37\frac{1}{2}$ "
Pitch "	18 "
Number of blades,	2.

Air Pumps.—Number and diameter of salt, } one of each, { $18\frac{1}{2}$ inch.
" " " fresh, } { $13\frac{3}{4}$ "

Pirsson's Condenser—Number of tubes, . 3705.

Outside diameter, $\frac{5}{8}$. Inside diameter, $\frac{1}{2}$. Length, 4 feet 10 inches over all. Tube sheets $\frac{3}{4}$ thick.

M.

For the Journal of the Franklin Institute.

Particulars of the Steamer George Anna.

Hull and machinery by Harlan & Hollingsworth & Co., Wilmington, Del. Owners, George R. H. Leffler.

Hull.—

Length on deck, . . . 208 feet
Breadth of beam, (molded) . . 30 "
Depth of hold, . . . 10 "
" " to spar deck, . . 18 "
Length of engine room, . . . 60 "
Frames—18 ins. apart from centres. Shape |; depth 3 ins. width ¾ in.
Plates—strakes from keel to gunwale 11; thickness ½, 7-16, and ⅜ inch.
Cross Floors—13 of 18 inches in height, × ⅜ and 7-16 with angle iron on top.
Keel—dimensions U 6 × ½ in.
Rivets—diameter ¾, distance apart 2 ins. single riveted.
Draft of water, . . . 6 "
Tonnage, . . 574 65-95.
Area of immersed section at load draft of 6 ft., 168 sq. ft.

Engine.—Vertical beam.

Diameter of cylinder, . . . 44 inches.
Length of stroke, . . . 11 feet
Maximum pressure of steam, . 30 lbs.
Cut-off—one-half.
Maximum revolutions per minute at above pressure, 22.
Weight of engines, . . 210,000 lbs.

Boilers.—One—Tubular.

Length of boilers, . . . 14 feet.
Breadth " . . 14 "
Height " exclusive of steam chimney, . 11 " 6 inches.
Weight " with water, . 90,000 lbs.
Number of furnaces, . . 4.
Breadth " . 3 ft. 6 in. and 2 " 6 "
Length of grate bars, . . . 6 "
Number of tubes, { above, . . 154.
{ below, . . 4 arches.
Internal diameter of tubes, { above, . . 3¾ "
{ below, same as furnace.
Length of tubes, . . . 5 " 6 "
Heating surface, . 2114 sq. ft.
Diameter of smoke pipe, . . 4 " 6 "
Height " above grates, . 46 "
Consumption of coal per hour, . about ¾ ton.

Paddle Wheels.—

Diameter over boards, . . . 28 feet.
Length of blades, . . 8 "
Depth " . . . 22 inches.
Number " . . 20.

Remarks.—One independent steam, fire, and bilge pump. Three bulkheads. Ceiling 1½-in. pine. Date of trial, September, 1859.

C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer Penguin.

Hull built by C. H. Mallory, Mystic, Conn. Machinery by C. H. Delamater, New York. Owners, Commercial Steamboat Company. Intended service, New York to Providence, R. I.

Hull.—			
Length on deck, from fore part of stem to after part of stern post, above the spar deck,		165 feet.	
Breadth of beam at midship section, above the main wales,		30 "	8 inches.
Depth of hold,		10 "	
Length of engine space,		10 "	
Floor timber, at throat—molded, 14 ins.—sided 9 to 11 ins. apart at centres, 26 ins.			
Draft of water at load line,		12 "	
" " below pressure and revolutions,		11 "	
Tonnage,	460.		
Area of immersed midship section at load line of 12 feet,	323 sq. ft.		
Masts and rig—three-masted schooner.			
Engine.—Vertical direct (Ericsson's patent).			
Diameter of cylinders, two,			48 inches.
Length of stroke,		2 feet.	
Maximum pressure of steam in pounds,	30.		
Maximum revolutions per minute,	70.		
Boilers.—One—Return tubular.			
Length of boiler,		20 feet.	
Breadth "		14 "	
Height " exclusive of steam chimney,		13 "	6 inches.
Number of furnaces,	3.		
Breadth "		4 "	
Length of grate bars,		7 "	6 "
Number of tubes,	93.		
Internal diameter of tubes,			3½ "
Length of tubes,		15 "	
Heating surface,	2000 sq. ft.		
Diameter of smoke pipe,		4 "	2 "
Height "		20 "	
Propeller.—			
Diameter of screw,		11 feet	6 inches.
Pitch "		20 "	
Length of blades,		4 "	6 "
Number	4.		

Remarks.—Spar deck inclosed.

C. H. H.

Electric Brakes for Railroads.

The *Cosmos* mentions the electric brake of M. Achard as having been entirely successful, either for checking or arresting the motion of the trains. With express trains, whose wheels are making from 400 to 500 turns in a minute, the rotation is stopped in a second, and the train slides over a distance of from 60 to 80 metres (yards). It will be remembered that a correspondent in a late number of the *Jour-*

nal, spoke of these brakes as having failed and been abandoned, but he appears to have been mistaken. The first experiments we remember to have heard of, on the application of magnetism to the purpose of brakes, were at or near Pittsburg. Can any of our readers refer us to the publication in which an account of them may be found? Ed.

For the Journal of the Franklin Institute.

Particulars of the Steam-tug Indio.

Hull and machinery built by Harlan & Hollingsworth & Co., Wilmington, Del. Owners, Fernando J. L. Calvo.

Hull.—		
Length on deck,		86 feet.
Breadth of beam, (molded)		18 "
Depth of hold, to spar deck,		8 "
Length of engine room,		30 "
Frames—18 ins. apart from centres. Shape I; depth 3 ins. width of web ⅜-in.		
Plates—strakes from keel to gunwale 7; thickness 5-16 in.		
Cross floors—9 of 22 ins. height × 5-16 in. thick.		
Keel—depth 12 ins. dimensions ⅜ U.		
Rivets—diameter ⅜-in.; distance apart 2 in. Single riveted.		
Draft of water,		6 " 9 inches.
Tonnage,	113 93-95.	
Area of immersed section at load draft of 6 feet 9 inches,	78 sq. ft.	
Engine.—Vertical direct.		
Diameter of cylinder,		26 inches.
Length of stroke,		2 feet.
Maximum pressure of steam,	40 lbs.	
Cut-off—one-half.		
Maximum revolutions per minute, at above pressure,	100.	
Weight of engines,	28,000 lbs.	
Boiler.—One—Return flue.		
Length of boiler,		13 feet 6 inches.
Breadth "		7 "
Height " exclusive of steam chimney,		7 "
Weight " with water,	34,000 lbs.	
Number of furnaces,	2.	
Breadth "		3 "
Length of grate bars,		5 " 6 "
Number of flues, above,	14.	
Number of flues, below,	6.	
Internal diameter of flues, above,		6 "
Internal diameter of flues, below,		8, 12, & 16 "
Length of flues, above,		9 feet 6 "
Length of flues, below,		6 "
Heating surface,	552 sq. ft.	
Diameter of smoke pipe,		3 " 2 "
Height " above grate,		30 " 6 "
Consumption of coal per hour,	about ¼ ton.	
Propeller.—		
Diameter of screw,		7 feet.
Length "		2 " 10 inches.
Pitch "		12 "
Number of blades,	4.	

Remarks.—One bulkhead. Date of trial, July, 1859. C. H. H.

*On the Application of Superheated Steam in Marine Engines.**
By Mr. J. Penn, President.

The paper was of a technical character, but of great interest to practical men. The writer stated that an opinion in favor of superheating the steam supplied to steam engines had long existed, and it had been maintained that important advantages might be obtained from this principle, though until recently but little had been effected in its practical application. Superheated steam seemed to have been first definitely tried by Mr. Thomas Howard, of Rotherhithe, about twenty-seven years ago. Considerable economy was effected, but the machine was too delicate in its construction to test the experiment properly (though it established the principle), and it was given up. Soon afterwards Dr. Haycroft, of Greenwich, took up the subject, and was convinced of its advantages. The importance of the principle was first impressed upon the writer many years ago, and he became satisfied, from the results of experiment and observation, that great advantages in economy of fuel might be obtained, the main question to be settled being whether it involved any serious practical objection from complication of apparatus, risk of derangement and failure, or difficulty in lubrication of the engine. Recent trials, made on a large scale, led the writer to the following conclusions:—That an advantage can be obtained from the use of superheated steam, amounting to an economy of fuel of from 20 to 30 per cent. in marine engines; that a moderate extent of superheating enables all the important advantages of the plan to be obtained; and that apparently nothing objectionable is then necessarily involved from extra wear and tear, risk of failure, complication of apparatus, or difficulty in lubrication. The real advantage in employing superheating steam appeared to be in preventing the presence of any water in the cylinder of the engine, and ensuring that it should be occupied always by nothing but pure steam; making it a real steam engine, instead of one working with a mixture of water and steam. In all condensing engines the interior of the cylinder, being open to the condenser during half the time of each revolution of the crank, was exposed during that time to the low temperature of the condenser, or about 125 degrees, with a vacuum of 13½ lbs. per inch below the atmosphere, or 27 inches of mercury. There was, consequently, a rapid absorption and radiation of heat from both the sides and the end of the cylinder, thus cooling down the whole mass of metal. The steam admitted into the cylinder in the next stroke, at a temperature of 260 deg. if at 20 lbs. per inch above the atmosphere, coming in contact with these cooled surfaces, heated them up again, being robbed thereby of a portion of its heat; and the consequence was the deposit of a quantity of water in the cylinder, from the condensation of an amount of steam proportionate to the quantity of heat imparted to the metal of the cylinder. A portion of this water in the cylinder might be evaporated again into steam towards the end of the stroke, by carrying the expansion of the steam down to a sufficiently low pres-

* From the Lond. Mechanics' Mag., Sept., 1859.

sure: but even then its effective value as steam in propelling the piston would have been lost during all the previous position of the stroke. Now, if as much heat be added to the steam, by superheating it before entering the cylinder, as would supply the amount of which it was robbed by the cylinder, it would remain perfectly dry steam throughout its stroke, and not a drop of water would be deposited. This, the writer believed, was the mode in which the superheating of steam acted in producing a saving of steam, and consequent economy of fuel, by preventing the extensive loss or waste of steam that ordinarily took place. The addition of 100 degs. of heat to the temperature of the steam insured the accomplishment of the desired object with steam at 20 lbs. per inch, as used in marine engines. The writer then proceeded into more technical details, reference being frequently made to the diagrams, and said, that having fitted the engines of the Peninsular and Oriental Company's steamer *Valletta* with superheating apparatus (illustrated by diagrams), the experiments made gave a saving of 20 per cent. of fuel. These experiments were not complete, but they were entirely satisfactory as far as they went.—A very interesting though technical discussion ensued, in which Mr. W. S. Ward, Mr. Morrison, Mr. Cowper, Mr. Maudslay, the President, and other gentlemen took part; after which a vote of thanks was passed to the President for his paper.—*Proceedings of the Ins. of Mech. Engineers.*

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*Artificial Statuary Marble.** By M. Jobard.

The following is extracted from the foreign correspondence of the *Star*:—"M. Jobard, of Brussels, who has almost suffered himself to be forgotten, from the lengthened and unusual silence he has maintained for some time past, has come out again as enthusiastic and vivacious as ever with his invention of artificial statuary marble—not the veiny, greasy stuff in use for chimneys and vases, but the pure and spotless Carrara, transparent, polished, and hard as the real substance taken from the quarry. This marble, which is to be prepared for the sculptors in a liquid state, will, like many other artificial inventions, possess an immense advantage over the natural production itself. It can be moulded on the plaster figure, and thus, instead of having to hack and hew a shapeless block with great pains and labor, the artist will henceforth realize the genuine impression of his cast at once, and, with scarcely any further exertion, bring out his creation with all the freshness and vigor of the first idea. The invention, which has created an immense sensation in the world of art, is due to a practical chemist of Brussels, of the name of Changy, the same skilful practitioner who discovered the divisibility of the electric light, and the miraculous draft of fishes by means of the chemical light which is sunk at the bottom of the sea. M. Jobard, whose word cannot be doubted, pledges his honor that the table on which he writes has been composed by M. Changy's process, and possesses every quality of the finest marble—and

* From the Mechanics' Magazine, Sept., 1859.

that, after having submitted various specimens of the substance, both black and white, to every chemical test in use, he has come to the conclusion that the composition of marble is no longer a secret of Dame Nature, and that man has at length learnt to rival her in the most cunning of her works, while Art will rejoice at beholding her sons freed from the laborious toil which has hitherto rendered the sculptor's profession difficult of pursuit."

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*A New and Simple Method of Extracting the Roots of All Powers.**

The extraction of roots without the use of logarithms, has hitherto been a task so tedious and perplexing that a correct and easy solution of all questions in evolution will be welcomed, not only by mathematicians, but also by the schoolmaster, as the time at present wasted upon almost impracticable formulæ will be usefully employed in the attainment and understanding of an important process; and the following rule is proposed for adoption in preference to others, which, with double the labor, yield only approximate results.

By this method the approach to truth is so rapid, that, with a slight exercise of judgment in selecting the trial root, either from memory or inspection, the true root is obtained more easily and more quickly than by the use of logarithms, and the operator is made independent of tables, which are not always available for reference.

The practical utility of this rule in questions of many periods, is shown by there being no necessity for prosecuting the division of large numbers beyond two or three quotient figures in each trial. (See example 3.)

The process is based upon the slow increase of the root compared with the expansion of the number raised by any power; and the error of supposition in the trial root is compensated by the mean taken (see examples 1, 2) where the trial roots are purposely taken wide of the apparent roots to show how quickly they converge to the true root.

Rule for the Extraction of the Roots of All Powers.

1st. Divide the given number by the trial root passed to the next less power. To the quotient add the trial root multiplied by the index of the next less power, and divide the sum by the index of the given power for a new trial root, with which repeat this simple operation, if necessary:—

Example, merely to show the process:—

Find the cube root of 8, using its true root, 2, for a trial root:—

2^2 (*i. e.* raised by ^{2} next less power to the cube), 4)8

2 (*see note.*)

Add 2 (the trial root × by next less power 2), 4

÷ by given power, the cube, 3)6

2 True root.

* From the Lond. Builder, No. 866.

NOTE.—The true root and the trial root need not necessarily agree; but when they do, or when the trial root and the first quotient are alike, the true root is found without proceeding further; also when the root repeats itself in the second operation it is the true root. (See Example 1.)

EXAMPLES.

1st. Find $\sqrt[3]{}$ of 125, assuming 4 for a trial root.

$4^2 = 16)125$

$7{\cdot}81 + 8 = {}^3)15{\cdot}81$

$5{\cdot}27$ New root.

Here we learn that it is *nearer* the 5 found than the 4 assumed; then try 5. $5^2 = 25)125$

5 The true root at once.

But with 4·9 or 5·1:—

$4{\cdot}9^2 = 24{\cdot}01)125$	$5{\cdot}1^2)125$
$+5{\cdot}2$	$4{\cdot}8 -$
$-9{\cdot}8$	$10{\cdot}2 +$
$3)15.$	$3)15{\cdot}0$
$5{\cdot}$	$5{\cdot}$

Root repeats with either.

2d. Find $\sqrt[3]{}$ of 1728 by trial of 10, 11, and 13.

$10^2 = 100)1728 + 20 = {}^3)37{\cdot}28 = 12.42$

$11^2 = 121)1728$

$14\dot{3} + 22 = {}^3)36{\cdot}3 \quad = 12{\cdot}1$

$13^2 = 169)1728$

$10{\cdot}22 + 26 = {}^3)36{\cdot}22 = 12{\cdot}07$

$12^2 = 144)1728 = 12$ True root.

3d. Required $\sqrt[3]{}$ of 10·973903978085048. Try either 2·1, 2·2, or 2·3, because we know them to be something near the root of 10. Take 2·2.

$2{\cdot}2^2 \quad 4{\cdot}84)10{\cdot}97390(2{\cdot}267$

$4{\cdot}4$

$3)6{\cdot}667$

$2{\cdot}222$

$2{\cdot}22$ Try

$4{\cdot}9284)10{\cdot}9739039(2{\cdot}22666$

$4{\cdot}44$

$3)6{\cdot}66666$

True root . . . . . . 2·22222

The facilities and perfect accuracy of the rule are here apparent.

SQUARE ROOTS.

The extraction of the square root is, by this method, a question of simple division.

4th. Find square root of 765625. Try 860.

$$
\begin{array}{r}
86{\cdot}0)765625(890 \\
860 \\
\hline
2)1750 \\
\hline
875 \text{ True root.}
\end{array}
$$

FORMULA.

Let

$$\left.\begin{array}{l} a = \text{given number} \\ b = \text{trial root} \\ x = \text{true root} \end{array}\right\} \text{When } x^n = a.$$

$$\text{Then } x = \frac{1}{n}\left(\frac{a}{b^{n-1}} + b\,(n-1)\right) \text{Nearly or quite.}$$

CHARLES HOARE,
Author of "Mensuration made Easy," &c.

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*Manufacture of Horn, Hoof, and Tortoise-shell Articles from Raspings, Saw-dust, and Waste.**

Horn, as a raw material, is possessed of many qualities which would render it well fitted for working up in the better kinds of furniture and cabinet work, were it not that it is limited in size to such comparatively small plates as the natural animal growth, when opened out flat, will produce. It is hard, and very durable, whilst it works easily and is of great cohesive strength; being capable of withstanding a tensile strain of from 12,000 to 16,000 pounds. per square inch, before giving way. It is also capable of receiving a very high and fine polish without the aid of paste, varnish, or other foreign matter. Now, if, with all these qualifications, we could obtain horn in plates or masses of superior size, we should at once bring the material into wide use for a multitude of purposes, to which, at present, it cannot be applied, by reason of its irregular shape and diminutive size. Such a result appears to have first been satisfactorily obtained by Mr. James Macpherson, the comb manufacturer of Aberdeen. This gentleman has very ingeniously discovered, that by the simplest possible process, he can solidify the raspings, saw-dust, and other waste of horns, hoofs, and tortoise-shell so as to produce large plates, sheets, and blocks of fine solid horn. He has also found that by a generally similar course of procedure, he can solidify, cement, or join portions of his raw materials, so as to secure, not only an increase in dimensions, but also a variety and increased beauty of effect, as regards color and fibre—as when

* From the Lond. Practical Mechanic's Journal, June, 1859.

two kinds of horn, or horn and shell, are joined together, or when differently colored portions are cemented into one mass.

In preparing a slab or a moulded article from the waste material, Mr. Macpherson proceeds by primarily placing a quantity of the disintegrated material, well cleansed and freed from grease and foreign matters, in a pressing cloth. The mass so bound up, is then soaked in water, which may either be boiling or have been previously boiled, so as to expel the air, which would otherwise interfere, to some extent, with the cohesion of the particles: water, in which is dissolved about one ounce of lime and one and a half ounces of potash to each three gallons, is the best suited for this fluid treatment. The moistening so given to the horn, begins the process of decomposition, thereby cleansing the surfaces and rendering them properly fitted for uniting. The moistened and partially softened mass is then enclosed in a preparatory mould, heated up to nearly the temperature ordinarily used in pressing and moulding articles of horn, or about 300° Fahrenheit. Pressure is then applied to the mould, so as to expel all the superfluous moisture, and bring the material into a block or slab of nearly the size and shape of the article wanted. After being allowed to remain in the mould for a few minutes, to give the mass firmness and consistency, it is withdrawn, and subsequently placed in the finishing mould, which is, of course, of the exact size and shape of the article to be made. In this stage of the operation, the greatest care must be taken to secure a fine regular heat, just as if the article were to be pressed and moulded in solid horn, as at present practised. The mould surface must be free from oleaginous matter; but to prevent adhesion, it may be very lightly touched with fine grease. In this moulding operation, the block may be inlaid with metal or pearl for ornamental work. The smaller and finer the waste dust used, the finer will be the work; so that it is advisable to preserve the finest and purest material for the surfaces, whilst the coarser portions are kept in the centre. Much of the excellence of the work produced, will, of course, depend upon the moulds and the pressure used in working them—as a pressure of from 3000 to 4000 lbs. per square inch is necessary for securing the due solidification of the particles.

From 60 lbs. of horn saw-dust or shavings, a fine slab of an area of 12 square feet, and three-fourths of an inch in thickness, suitable for the top of a table, can be produced—of course, such a slab may be of any form and of a variable thickness, just as the exigencies of the design may demand. The moulded surfaces are perfectly smooth, directly from the mould; but the polishing is an after process, although the dyeing or artificial coloring, when that is required, can be performed simultaneously with the actual moulding—the raw materials themselves being dyed or stained prior to the pressure being applied.

The same general principle applies also to the cementing or junction of distinct pieces of horn, hoof, or tortoise-shell. In this process, the pieces are neatly fitted together, and then moistened, the parts being covered over with paper to confine the water and steam, and prevent the atmosphere from acting upon the surfaces at the instant of cementation. A pair of tongs, suitable for grasping the scarfed

5*

portions, are then heated to the proper moulding temperature, and the parts grasped therewith are then placed in a vice, with sufficient squeezing force upon them to cause the work to extend under the tongs.—The work is then left until it is cold, when a perfect joint is produced, the whole mass being homogeneous.

The simplicity of the entire process is a great feature in its favor, and, as the moulded material presents all the appearance of real solid horn, with many artificial beauties which that material does not possess, it is reasonable to suppose that the invention will work a considerable change in the horn and collateral manufactures. One pound weight of natural horn, contains about 22 cubic ins. of material, and the solidified horn is of about the same density, although from its appearance, and we have several samples of the work before us, the artificial substance seems even more dense. It never becomes fluid during the treatment which it receives, and in all the operations of bringing up and polishing the surface, it is subject to all the conditions and laws affecting the natural material from which it is made, when in its original form; the only difference is, that the new material is fibreless, there being no grain in it, so that it is equally strong in all directions.

Mr. Macpherson has submitted seven of his early samples to us.—One of these consists of two pieces of horn cemented together, the two being chosen of very dissimilar colors, and set with their natural grains crossing each other, so as to exhibit the accuracy and beauty of the junction very clearly. Another is composed of two pieces of hoof similarly cemented. These pieces present an excellent effect, more like tortoise-shell than ordinary horn. A third specimen shows what can be obtained by dyeing the dust black prior to the first moulding, and then inlaying the surface with silver, in the after moulding process. The other samples show the plain moulded saw-dust prior to polishing—a slab of moulded shavings dyed in the first process—a slab of solidified horn dust as taken off by the grind-stones in reducing horn combs—and a highly polished slab of solidified dust. The material seems well suited for ornamental panels, work-boxes, dressing-cases, door-knobs, and other articles not easily made out of natural horn.

As to the labor cost of producing articles from the artificial material, it is to be remembered that in treating ordinary horn or hoof, it must be all dressed clean with a knife before it can be put into a mould, and there is always a loss of material of from 25 to 50 per cent. of the whole. This work is done by a skilled mechanic, and occupies a large amount of time. On the other hand, the waste material can be weighed out to the exact quantity for the article to be made, and no loss arises; and when artificial coloring is necessary, the waste can be all dyed through by simple immersion in the boiling dye for a few minutes, whilst solid horn takes some hours to dye, and is then only stained on the surface. The solid tops of horn, when good, sell for £30 a ton; the waste can be had for £6 or £8 a ton, and a greater relative quantity can be turned to useful account from the waste than from solid horn. The process thus affords a means of economically working up what is otherwise a cheap waste material, of which many hundred tons are annually produced in this country.

*New Plastic Metallic Alloy.**

This metallic alloy, which has been discovered by M. Gersheim, not only adheres forcibly to other substances or compositions, such as glass and porcelain, but serves also to unite them in the same way as mastic. After ten or twelve hours, this plastic alloy attains a hardness which renders it capable of bearing a high polish, similar to silver or brass.

In preparing this alloy, oxide of copper is reduced by means of hydrogen, or sulphate of copper is precipitated with zinc parings. By this means a pure copper is obtained, twenty, thirty, or thirty-six parts of which are taken according to the hardness desired—the more copper in the alloy the greater being the hardness thereof. This is moistened in a cast iron or porcelain mortar with concentrated sulphuric acid, of a density of 1·85. To this species of metallic paste are added seventy parts by weight of mercury—the mass being kept continually stirred or agitated. When the copper is completely amalgamated, the composition is washed with boiling water to remove the sulphuric acid; it may then be left to cool, and ten or twelve hours will be sufficient to render it hard enough to bear an excellent polish, and to scratch tin and bone. It is not acted upon either by weak acids, alcohol, ether, or boiling water; and its density remains the same whether it is plastic or hard. When required as a mastic, it may at any time be reduced to a soft and plastic condition by submitting it to a heat of about 375° Centigrade, and working it in an iron mortar, heated to about 125° Centigrade, until it has attained the malleability and consistency of wax. If in this state it is placed between two metallic surfaces well freed from oxidation, it will unite them so perfectly that in ten or twelve hours afterwards they may be submitted to any usage. This composition, in a soft state, may also be poured into hollows, into which it will adhere forcibly after it has hardened, as it is found that it does not shrink in changing its condition.

The peculiar properties of this alloy admit of its application to a great variety of uses, but it is especially useful in the uniting of metallic surfaces where it would be inconvenient to employ heat for soldering or brazing the parts. Whilst on this subject, we may mention that Professor Pettenkofer, of Munich, discovered a sure method of preparing the amalgam of copper, which is now employed by dentists in stopping teeth, as far back as 1845.

On the Specific Gravities of Alloys.† By F. Crace Calvert, Ph.D., F.R.S., F.C.S., and Richard Johnson, F.C.S., &c.

The study of alloys and amalgams having been made especially with impure or commercial metals, the results obtained have been such that it has been impossible to solve the important question, Are alloys and amalgams chemical mixtures or compounds? It is with the hope of throwing some light on this subject, that we have for the last two years

* From the Practical Mechanic's Journal, Nov. 1859.

† From the Lond., Edin., and Dub. Philosophical Mag., Nov., 1859.

been engaged in examining comparatively some of the physical properties, such as the conductibility of heat, tenacity, hardness, and expansion of alloys and amalgams made with pure metals, and in multiple and equivalent quantities, as follows:—

1 Copper and 1 Tin.	1 Tin and 2 Copper.
1 " and 2 "	1 " and 3 "
1 " and 3 "	1 " and 4 "
1 " and 4 "	1 " and 5 "
1 " and 5 "	

By this method we have succeeded in ascertaining, first, the influence which each additional equivalent quantity of a metal exerts on another; secondly, the alloys which are compounds and those which are simple mixtures; for compounds have special and characteristic properties, whilst mixtures participate in the properties of the bodies composing them. This method of investigating alloys and amalgams has enabled us to ascertain which metals combine together to form definite compounds, and those which, when melted together, only form mixtures. Thus, for example, bronze alloys are definite compounds, for each alloy has a special conductibility of heat. Thus the alloy.

	Obtained.	Calculated.*	Difference.
$Sn\,Cu^2$	13·65	19·87	6·22
$Sn\,Cu^3$ . . .	15·75	21·37	5·62
$Sn\,Cu^4$	4·96	21·88	16·92
$Sn\,Cu^5$ . . .	6·60	22·50	15·90

These same alloys have a specific gravity of their own. Thus:—

	Obtained.	Calculated.*	Difference.
$Sn\,Cu^2$	8·533	8·059	0·474
$Sn\,Cu^3$ . . .	8·954	8·208	0·756
$Sn\,Cu^4$	8·948	8·306	0·642
$Sn\,Cu^5$ . . .	8·965	8·374	0·591

The same fact is also observed in the expansion or contraction of these alloys. Whilst, on the contrary, the alloys of tin and zinc being mixtures, conduct heat, have a specific gravity, and expand according to theory, or the proportion of tin and zinc which compose each alloy. Thus for heat:—

	Obtained.	Calculated.*	Difference.
$Zn\,Sn^2$	15·15	14·90	0·25
$Zn\,Sn$.	16·00	15·80	0·10
$Zn^2\,Sn$	16·65	16·95	0·30

Specific Gravity.

	Obtained.	Calculated.*	Difference.
$Zn\,Sn^2$	7·274	7·193	0·081
$Zn\,Sn$ . . .	7·262	7·134	0·128
$Zn^2\,Sn$	7·188	7·060	0·128

We shall divide our researches on the specific gravity of alloys and amalgams under two heads: first, those which have a higher specific gravity than indicated by theory; and secondly, those which have a less specific gravity or expand.

* The principle upon which the theoretical conductibility, specific gravity, and expansion are calculated, is similar to that followed with respect to hardness, for which see page 4 of our paper "On Hardness." (See Jour. Franklin Ins. present Series, Vol. xxxvii. p. 199.)

I. Alloys which have a higher specific gravity than indicated by theory. Results:—

Copper and Tin (Bronze).

Formulæ of alloys and per centages.		Obtained.	Calculated.	Difference.
$CuSn^5$	Cu 9·73, Sn 90·27	7·517	7·431	0·086
$CuSn^4$	Cu 11·86, Sn 88·14	7·558	7·462	0·096
$CuSn^3$	Cu 15·21, Sn 84·79	7·606	7·514	0·092
$CuSn^2$	Cu 21·21, Sn 78·79	7·738	7·580	0·158
$CuSn$	Cu 34·98, Sn 65·02	7·992	7·805	0·187
$SnCu^2$	Sn 51·83, Cu 48·17	8·533	8·059	0·474
$SnCu^3$	Sn 38·21, Cu 61·79	8·954	8·208	0·746
$SnCu^4$	Sn 31·73, Cu 68·27	8·948	8·306	0·642
$SnCu^5$	Sn 27·10, Cu 72·90	8·965	8·374	0·591
$SnCu^{10}$	Sn 15·68, Cu 84·32	8·832	8·545	0·287
$SnCu^{15}$	Sn 11·03, Cu 88·97	8·825	8·615	0·210
$SnCu^{20}$	Sn 8·51, Cu 91·49	8·793	8·634	0·159
$SnCu^{25}$	Sn 6·83, Cu 93·17	8·820	8·677	0·143

Copper and Zinc (Brass).

Formulæ of alloys and per centages.		Obtained.	Calculated.	Difference.
$ZnCu^5$	Cu 82·95, Zn 17·05	8·673	8·453	0·220
$ZnCu^4$	Cu 79·56, Zn 20·44	8·650	8·387	0·263
$ZnCu^3$	Cu 74·48, Zn 25·52	8·576	8·290	0·286
$ZnCu^2$	Cu 66·06, Zn 33·94	8·488	8·129	0·359
$ZnCu$	Cu 49·32, Zn 50·68	7·808	8·319	0·511
$CuZn^2$	Cu 32·74, Zn 67·26	7·859	7·489	0 370
$CuZn^3$	Cu 24·64, Zn 75·36	7·736	7·334	0·401
$CuZn^4$	Cu 19·57, Zn 80·43	7·445	7·237	0·208
$CuZn^5$	Cu 16·30, Zn 83·70	7·442	7·174	0·268
Copper and Bismuth.				
$CuBi$		9·634	9·566	0·068
Copper and Antimony.				
$CuSb$		7·990	7·386	0·604

Tin and Zinc.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
Zn Sn^2 { Zn 21·65, Sn 78·35 } . .	7·274	7·193	0·081
Zn Sn { Zn 35·60, Sn 64·40 } . .	7·262	7·134	0·128
Sn Zn^2 { Sn 47·49, Zn 52·51 } . .	7·188	7·060	0·128
Sn Zn^3 { Sn 37·57, Zn 62·43 } . .	7·180	7·021	0·159
Sn Zn^4 { Sn 31·14, Zn 68·86 } . .	7·155	6·993	0·162
Sn Zn^5 { Sn 26·57, Zn 73·43 } . .	7·140	6·974	0·166
Sn Zn^{10} { Sn 15·32, Zn 84·68 } . .	7·135	6·927	0·208

II. Alloys and amalgams having a less specific gravity, or which expand.

Mercury and Tin.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
Hg Sn { Hg 62·97, Sn 37·03 } . .	10·255	11·259	1·004
Hg Sn^2 { Hg 45·88, Sn 54·12 } . .	9.314	10 180	0·866
Hg Sn^3 { Hg 36·18, Sn 63·82 } . .	8·805	9·568	0·763
Hg Sn^4 { Hg 29·84, Sn 70·16 } . .	8·510	9·168	0·658
Hg Sn^5 { Hg 25·38, Sn 74·62 } . .	8·312	8·885	0·573
Hg Sn^6 { Hg 22·08, Sn 77·92 } . .	8.151	8·678	0·527

Mercury and Bismuth.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
Hg Bi { Hg 48·44, Bi 51·56 } . .	11·208	11·638	0·430
Hg Bi^2 { Hg 31·82, Bi 68·18 } . .	10·693	11·007	0·314
Hg Bi^3 { Hg 23·86, Bi 76·14 } . .	10·474	10·70 4	0·230
Hg Bi^4 { Hg 19·03, Bi 80·97 } . .	10·350	10·522	0·172
Hg Bi^5 { Hg 15·82, Bi 84·18 } . .	10·240	10.410	0·170
Mercury and Zinc.			
Hg Zn	11·304	11·944	0·640

Antimony and Bismuth.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
Bi Sb^6 { Bi 24·81, Sb 75·19 } . .	7·271	7·470	0·201
Bi Sb^4 { Bi 29·20, Sb 70·80 } . .	7·370	7·606	0·235
Bi Sb^3 { Bi 35·48, Sb 64·52 } . .	7·561	7·801	0·240
Bi Sb^2 { Bi 45·21, Sb 54·79 } . .	7·829	8·102	0·273
Bi Sb { Bi 62·26, Sb 37·74 } . .	8·364	8·630	0·268
Sb Bi^2 { Sb 23·26, Bi 76·74 } . .	8·859	9·077	0·218
Sb Bi^3 { Sb 16·81, Bi 83·19 } . .	9·095	9·277	0·182
Sb Bi^4 { Sb 13·17, Bi 86·83 } . .	9·276	9·391	0·115
Sb Bi^5 { Sb 10 82, Bi 89·18 } . .	9·369	9·464	0·095
Bismuth and Zinc.			
Bi Zn	9·046	9·132	0·086

Tin and Lead.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
Pb Sn^5 { Pb 26·03, Sn 73·97 } . .	8·093	8·367	0·254
Pb Sn^4 { Pb 30·57, Sn 69·43 } .	8·196	8 548	0·352
Pb Sn^3 { Pb 36·99, Sn 63·01 } . .	8·418	8·823	0·405
Pb Sn^2 { Pb 46·82, Sn 53·18 } .	8·774	9·232	0·458
Pb Sn { Pb 63·78, Sn 36·22 } . .	9·458	9·938	0·480
Sn Pb^2 { Sn 22·11, Pb 77·89 } . .	10·105	10·525	0·420
Sn Pb^3 { Sn 15·91, Pb 84·09 } .	10·421	10·783	0·362
Sn Pb^4 { Sn 12·43, Pb 87·57 } . .	10·587	10·927	0·340
Sn Pb^5 { Sn 10·20, Pb 89·80 } . .	10·751	11·017	0·266

Lead and Antimony.

Formulæ of alloys and per centages.	Obtained.	Calculated.	Difference.
$SbPb^6$ { Sb 11·08, Pb 88·92 }	10·556	10·919	0·363
$SbPb^4$ { Sb 13·48, Pb 86·52 }	10·387	10·805	0·418
$SbPb^3$ { Sb 17·20, Pb 82·80 }	10·136	10·629	0·493
$SbPb^2$ { Sb 23·68, Pb 76·32 }	9·723	10·321	0·598
$SbPb$ { Sb 38·39, Pb 61·61 }	8·953	9·624	0·671
$PbSb^2$ { Pb 44·53, Sb 55·47 }	8·330	8·959	0·629
$PbSb^3$ { Pb 34·86, Sb 65·14 }	7·830	8·355	0·525
$PbSb^4$ { Pb 28·64, Sb 71·36 }	7·525	8·059	0·534
$PbSb^5$ { Pb 24·31, Sb 75·69 }	7·432	7·854	0·422

These researches reveal two important facts: first, that there is one metal the alloys of which always contract, viz: those of copper, whilst all the amalgams expand or have a less specific gravity; secondly, that the maximum expansion or contraction of alloys and amalgams generally occurs in those which are composed of one equivalent of each metal, the exception being those of tin and zinc. But this arises no doubt from the fact that all the alloys, with the exception of the latter, are compounds and not mixtures.

We must, in conclusion, draw attention to the extraordinary contraction or expansion that some of these alloys experience. Thus, for example, the alloy of 8 of copper and 1 of tin:—

Found.	Calculated.	Difference.
8·954	8·208	0·746

whilst the amalgams of tin expand to nearly the same extent, as shown by these results:—

	Found.	Calculated.	Difference.
1 of Mercury, 1 of Tin,	10·255	11·259	1·004

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*On the Coating of Engraved Copper Plates by the Galvanoplastic Process.** By Dr. H. Meidinger.

The extremely remarkable application of the electrotype, which cannot fail to come into general use in the preparation of copper plates, and to diminish their cost considerably, has recently been repeated by a Frenchman of the name of Jacquin. Several years ago Prof. Böttger showed that iron could be easily separated by the galvanic current from a solution of 1 part of ammonia and 2 parts of sulphate of iron. It then presents the appearance of a silver-white speculum, and ad-

* From the Lond. Chemical Gazette, No. 406.

heres quite firmly in thin layers upon well-cleaned metallic surfaces of copper, brass, &c.; but a thicker deposit separates again readily on bending. This perfectly pure iron precipitated by galvanism possesses quite different physical properties from that obtained by the process of smelting, which always contains intermixtures, although often in small quantities, of foreign bodies, especially carbon; that obtained by galvanism is as hard as steel and as brittle as glass. Upon this property depends Jacquin's discovery, which is, at the same time, the first technical application of iron deposited by galvanism.

Engravings on copper are well known to lose greatly in sharpness and expression after the first few hundred impressions have been worked off (these are consequently more highly prized and command a far better price in the market). This falling off of the plates is due to the constant friction and the great pressure to which they are exposed, by which the surface of the plate is gradually rubbed away, and the engraving becomes lighter until it may even disappear entirely.

The electrotype has indeed already enabled us to make any number of identical copies of an engraved copper plate; the process is, however, uncertain in unpractised hands and rather expensive; and, moreover, an electrotype copy of a copper plate will only furnish a far smaller quantity of fine impressions than the original plate of hammered copper, as its surface is much more easily worn away. For this reason there is no doubt that Jacquin's method of treating the surface of the original plate itself in so simple, certain, and cheap a way, to enable it to furnish an almost unlimited number of equally good impressions, must be exceedingly welcome to all copper-plate engravers. This process consists, in brief, in coating the plate when completed with a very thin layer of galvanoplastic iron. In consequence of its extraordinary hardness, the latter undoubtedly resists wear much better than the soft copper; and even should it suffer in the course of working, or become detached in spots, there is nothing to prevent the rest of the iron from being removed entirely by means of dilute sulphuric acid without the least injury to the copper plate, which may then be furnished with a new coating in the galvanic bath.

In order that the operation may be successful, some precautions must be observed. As in all cases where a galvanic deposit is to adhere firmly to a metallic ground (as in gilding and plating, coppering zinc and iron, &c.), a perfectly clean surface must be offered to the deposit of iron; the engraved copper plate must not be in the least greasy or oxidized. The grease which may be produced upon it by mere contact with the fingers, is best removed by means of a little solution of caustic alkali; a solution of carbonate of soda may also fulfil the object. To remove oxide, the plate is immersed in dilute sulphuric acid, so that at last it appears perfectly bright. It is then washed with water, and put immediately into the iron-bath. Here it is attached to the negative pole by means of a copper wire, and opposite to it, at a uniform distance of half an inch to one inch, is placed a plate of iron of the same size united with the positive pole. By means

of a powerful battery (which, however, must never give rise to the formation of bubbles of hydrogen on the copper plate), a perfectly uniform coating of bright iron is obtained in a short time, from 5 minutes to a quarter of an hour. The prepared plate is then very quickly washed with pure water, and afterwards with a solution of carbonate of soda, dried with a fine cloth, and finally rubbed with a little oil or some other fatty matter in order to prevent any injurious effects of air and moisture; in fact, the plate is now treated just like an engraved steel plate, which it exactly resembles. The excess of ink is said to rub off the surface of the iron much more readily than off copper, so that the work of the printer is shortened by about half the time, in other words, twice as many impressions may be obtained in the same time. If this prove true, it forms a further and very valuable advantage of the new process.

As regards the composition of the saline bath, the author still considers the method described by Böttger as the best. The preparation of the bath by Jacquin's method, by means of the electrical current itself, by dissolving an iron plate connected with the positive pole in the solution of muriate of ammonia, is tedious, expensive, and inadmissible even upon theoretical grounds. The bath is, therefore, made with 2 parts of commercial sulphate of iron and 1 part of muriate of ammonia, which are mixed together and treated with water until the whole is dissolved; 2 pounds of sulphate of iron and 1 pound of muriate of ammonia require about 4 litres of water, when the solution amounts to not quite 5 litres. If the solution is to be employed directly, it must be previously boiled with fragments of iron plate (or nails), in order to convert any peroxide of iron that may be contained in the sulphate into protoxide, as the former would injure the deposit of iron. The same end is attained by leaving the solution for several days in contact with metallic iron in closed vessels. It is also necessary after use to preserve the solution in such a way that it may not readily combine with oxygen. The sign of its goodness is its pale green color; it must on no account possess any yellowish tinge. The formation of yellowish-brown or even black flakes in the solution during the operation cannot be entirely prevented; they are separated by filtration when convenient, but have no unfavorable influence upon the formation of the deposit of iron, if the copper plate be moved slowly to and fro in the bath.

The best form of cell for the decomposition is a wooden trough, of the length and depth of the copper plate, and about 2 inches clear in width; it should be coated internally with wax or pitch. If the iron plate which serves as the positive pole, and which dissolves during the operation in the same proportion that the iron is deposited upon the copper plate, and thus keeps the bath in a proper state, be fixed to one wall of the trough, it leaves sufficient space to allow the copper plate to be slightly vibrated. Such an arrangement is to be preferred in this case to the employment of a flat trough, which is advantageously used in the preparation of thick copper plates.

Daniell's battery produces a sufficiently strong current for the de-

composition of the solution of iron, if the negative excitant (the copper cylinder surrounding the zinc) possesses about the same amount of surface as the engraved copper plate. If the latter be very large, two or three Daniell's elements may be employed.—*Dingler's Polytechn. Journal*, clii. p. 359.

On the Resistance of Glass Globes and Cylinders to collapse from external pressure, and on the Tensile and Compressive Strength of various kinds of Glass. By WILLIAM FAIRBAIRN, Esq., C. E., F. R. S., and T. TATE, Esq., F. R. A. S.—Received May 3, 1859.

[From the Proceedings of the Royal Society, No. 35.]

The researches contained in this paper are in continuation of those upon the Resistance of Wrought Iron Tubes to collapse, which have been published in the "Philosophical Transactions" for 1858.* The results arrived at in those experiments were so important as to suggest further inquiry under the same conditions of rupture with other materials; and glass was selected, not only as differing widely in its physical properties from wrought iron, and hence well fitted to extend our knowledge of the laws of collapse, but because our acquaintance with its strength in the various forms in which it is employed in the arts and in scientific research is very limited. To arrive at satisfactory conclusions, the experiments on this material were extended so as to embrace the direct tenacity, the resistance to compression, and the resistance to bursting, as well as the resistance to collapse.

The glass experimented upon was of three kinds:—

	Specific gravity.
Best flint glass, . .	3·0782
Common green glass, .	2·5284
Extra white crown glass, . .	2·4504

Tenacity of Glass.—For reasons detailed by the authors, the experiments upon the direct tenacity of glass made by tearing specimens asunder are less satisfactory than those in the rest of the paper; and it is argued that more reliance is to be placed upon the tenacity deduced from the experiments on the resistance of globes to bursting in which water-pressure was employed, than upon the tenacity obtained directly by tearing specimens asunder. The results obtained by the latter method give the following mean results:—

	Tenacity per square inch in pounds.
Flint glass, . .	2413
Green glass, . .	2896
Crown glass, . .	2346

Resistance of Glass to Crushing.—The experiments in this section were made upon small cylinders and cubes of glass crushed between parallel steel surfaces by means of a lever. The cylinders were cut of the required length from rods drawn to the required diameter, when molten, and then annealed, in this way retaining the exterior and first cooled skin of glass. The cubes were cut from much larger portions,

* See Journ. Frank. Inst., present series, vol. xxxvi, pp. 145 and 227.

and were in consequence probably in a less perfect condition as regards annealing. Hence, as might have been anticipated, the results upon the two classes of specimens, although consistent in each case, differ widely from one another.

The mean compressive resistance of the cylinders, varying in height from 1 to 2 inches, and about 0·75 inch in diameter, is given in the following Table:—

Description of glass.	Height of cylinder in inches.	Mean crushing weight per square inch.		Mean crushing weight per square inch.	
		in pounds.	in tons.	in pounds.	in tons.
Flint glass, . .	1·0 1·5 2·0	29,168 20,775 32,803	13·021 9·274 14·644	27,582	12·313
Green glass, . .	1·0 1·5 2·0	22,583 35,029 38,105	10·081 15·628 16·974	31,876	14·227
Crown glass, .	1·0 1·5	23,181 38,825	10·348 17·332	31,003	13·840

The specimens were crushed almost to powder by the violence of the concussion; it appeared, however, that the fracture occurred in vertical planes, splitting up the specimen in all directions. Cracks were noticed to form some time before the specimen finally gave way; then these rapidly increased in number, splitting the glass into innumerable prisms, which finally bent or broke, and the specimen was destroyed.

The following Table gives the results of the experiments upon the cut cubes of glass:—

	Mean resistance to crushing	
	in pounds.	in tons.
Flint glass, . .	13,130	6·861
Green glass, .	20,206	9·010
Crown glass, .	21,867	9·762

Hence, comparing the results on cylinders with those on cubes, we find a mean superiority in the former case in the ratio of 1·61 : 1, due to the more perfect annealing of the glass.

On the Resistance of Glass Globes to Internal Pressure.—In these experiments the tenacity of glass is obtained by a method free from the objections to that before detailed. Glass globes, easily obtained of the requisite sizes, in a nearly spherical form, were subjected to an internal pressure obtained by means of a hydraulic pump, uniformly and steadily increased till the globe gave way. The lines of fracture radiated in every direction from the weakest part, passing round the globe as meridians of longitude and splitting it up into thin bands, varying from $\frac{1}{16}$th to $\frac{1}{8}$th of an inch in breadth.

The following Table gives the results of the experiments on the resistance of glass globes to internal pressure:—

Description of glass.	Diameters.	Thickness.	Bursting pressure per square inch.
	Inches.	Inches.	Pounds.
Flint glass, .	4·0×3·98	0·024	84
	4·0×3·98	0·025	93
	4·0	0·038	150
	4·5×4·55	0·050	280
	5·1×5·12	0·058	184
	6·0	0·059	152
Green glass, .	4·95×5·00	0·022	90
	4·95×5·00	0·020	85
	4·00×4·05	0·018	84
	4·00×4·03	0·016	82
Crown glass, .	4·2 ×4·35	0·025	120
	4·05×4·2	0·021	126
	5·9 ×5·8	0·016	69
	6·0 ×6·3	0·020	86

The formula which expresses the relation of the bursting pressure to the thickness and diameter of the globe, is—

$$P = \frac{a\,T}{A};$$

where a = the longitudinal sectional area of the material in square inches, that is in the line of rupture or line of minimum strength; A = the longitudinal sectional area of the globe in square inches; and T = the tenacity of the glass in pounds per square inch. Hence, from the above experiments we deduce—

Pounds.
T = 4200 for flint glass,
= 4800 for green glass,
= 6000 for crown glass,

5000 = mean tenacity of glass.

Here the mean tenacity is nearly twice that obtained in the experiments upon thick bars; a result, which perhaps corresponds with the difference between the crushing strength of cylinders and cubes, and is largely attributable to the condition of annealing.

On the Resistance of Glass Globes and Cylinders to an External Pressure.—The manner of conducting these experiments did not differ in any essential detail from that pursued in the experiments upon wrought iron. The globes and cylinders, after having been hermetically sealed in the blow-pipe flame, were fixed in a wrought iron boiler communicating with a hydraulic pump. In this position an increasing pressure was applied until the globes broke, the amount of pressure at the time being noted by means of a Schäffer pressure gauge. During the collapse the tubes were reduced to the smallest fragments, so that no indication of the direction of the primary lines of fracture could be discovered.

The following Table contains a summary of the results on glass globes subjected to an external pressure:—

Description of glass.	Diameters.	Thickness.	Collapsing pressure per square inch.
	Inches.	Inches.	Pounds.
Flint Glass,	5·05×4·76	0·014	292
	5·09×4 7	0·018	410
	4·95×4·72	0·022	470
	5·6	0·020	475
	8·22×7·45	0·010	35
	8·2 ×7·2	0·012	42
	8·2 ×7·4	0·015	60
	4·0 ×3·98	0·024	(900*)
	4 0	0 025	(900*)
	6·0	0·059	(1000*)
Green glass,	5·0 ×5·02	0·0125	212

* These globes remained unbroken.

The following Table contains a similar summary of the results upon cylindrical vessels:—

Description of glass.	Diameters.	Length.	Thickness.	Collapsing pressure per square inch.
	Inches.	Inches.	Inches.	Pounds.
Flint glass,	3·09	14·0	0·024	84
	3·08	14·0	0 032	103
	3·24	14·0	0·042	175
	4·05	7·0	0·034	202
	4·05	7·0	0·046	380
	4·06	13·8	0·043	180
	4·02	13·8	0·064	297
	3·98	14·0	0·076	382
	4·05	7·0	0 079	(500†)

† Remained unbroken.

The paper includes an investigation of the laws of collapse as exhibited in these results, and the following general formulæ are obtained:

For glass globes, . . $\text{P} = 28{,}300{,}000 \times \frac{k^{1\cdot4}}{\text{D}^{3\cdot4}}$,

For glass cylinders, . . $\text{P} = 740{,}000 \times \frac{k^{1\cdot4}}{\text{D L}}$,

where P = the collapsing pressure in pounds per square inch; k = thickness in inches; D and L = diameter and length respectively in inches.

These are the general formulæ for glass vessels subjected to an external pressure, and the latter is precisely similar to that found for sheet iron cylinders.

Transverse Strength of Glass.—The authors derive the general formula

$$\text{W} = 3140 \times \frac{\text{K.D}}{l},$$

where W = breaking weight in pounds, K = area of transverse section, D = depth of section, l = length between supports;—to express the transverse strength of a rectangular bar of glass supported at the ends and loaded at the middle.

*Tinned Lead Tubes.**

The authorities of Paris have prohibited the employment of lead for tubes intended to convey beer or water for drinking purposes. M. Sébille, of Nantes, has invented an ingenious process for tinning lead tubes inside or out, or both, which, from the specimens exhibited, appears eminently successful, and which has the merit of cheapening the article, by reason of the superior resisting power of the tin permitting the diminution of the leaden tube by about one-tenth of the ordinary thickness of metal. Tinned lead tubes have been found to possess sufficient rigidity to allow of their being worked and bent without bulging inwards and flattening. Taking 500 metres of ordinary lead tubing, mixed gauges, the weight will be 2460 kilos.; and at 70 francs the 10 kilos., the cost will be 1722 francs. Five hundred metres of the new tinned lead tubing, by reason of the reduction in the thickness of metal, will weigh 2214 kilos., which, at 76 francs the hundred kilos., will make the cost 1682 francs, or 39 francs less for a less destructible and stronger article. The machinery and process of manufacture are as follows:—The molten lead is run by a side opening into a cast iron vertical cylinder situated above the piston of an hydraulic press. The cylinder is closed at top by a cover having an opening of the diameter required, and in the centre of which is placed a mandril or core. The lead is allowed to solidify, that is to say, to fall to a temperature of from 482° to 518° Fah., at which it is kept by heat applied to the outside of the cylinder. When this temperature is reached, the hydraulic press is set working, and the lead expelled through the annular opening in the cover; the mandril in the centre of the opening is provided on its circumference with four knives, which scrape the interior surfaces of the lead. On leaving the annular opening, the lead comes into contact with molten tin, which penetrates into its pores, and is firmly attached to its whole surface. As tin melts at 446° Fah., the lead possesses sufficient heat to keep the tin always fluid. A ring on the exterior or sphere in the interior of the tube, fixed where it leaves the machine, regulates the thickness of the tin coating and smoothes its surface. The reason, it may be remarked, of the tin attaching itself to the lead without the previous use of a mordant is, that the knives clean the surface which comes in contact with the tin before it can be acted upon by the atmosphere. The gas and water companies in the French towns use M. Sébille's tinned lead tubes to the exclusion of all others, on account of their economical and sanitary advantages.

Condensed Abstract of a first set of Experiments, by Messrs. Robert Napier and Sons, on the strength of Wrought Iron and Steel.† By W. J. Macquorn Rankine, C.E., LL.D., F.R.S.

The experiments to which this abstract relates form the first set of a long series now in progress by Messrs. Robert Napier and Sons; the details being conducted by their assistant, Mr. Kirkcaldy. The whole

* From the London Civ. Eng. and Arch. Jour., Oct., 1859. † Ibid.

results are now in the course of being printed *in extenso* for publication in the Transactions of the Institution of Engineers in Scotland; but some time must elapse before they can appear, owing to the great volume of the tables and the number of particulars which they give.

The present abstract is all that it has been found practicable to prepare in time for the meeting of the British Association; and notwithstanding its brevity and extreme condensation, it is believed that the results which it shows will be found of interest and importance. It gives the tenacity, and the ultimate extension when on the point of being torn asunder, of the *strongest* and the *weakest* kinds of iron and steel from each of the districts mentioned. Each result is the mean of four experiments at least, and sometimes of many more. The detailed tables, now being printed, will show many more particulars; and especially the contraction of the bars in transverse area along their length generally, owing to the "drawing out," and the still greater contraction at the point of fracture. The experiments now complete were all made with loads applied gradually. Experiments on the effect of suddenly applied loads are in progress.

Table A. *Iron Bars.*

	Tenacity in lbs. per sq. in.	Ultimate extension in decimals of length.
Yorkshire, strongest	62886	0·256
" weakest	60075	0·205
" (forged)	66392	0·202
Staffordshire strongest	62231	0·222
" weakest	56715	0·225
West of Scotland, strongest	64795	0·173
" weakest	56655	0·191
Sweden, strongest	48232	0·264
" weakest	47855	0·278
Russia, strongest	56805	0·153
" weakest	49564	0·133
Table B. *Iron Plates.*		
Yorkshire, strongest lengthwise	56005	0·141
" weakest "	52000	0·132
" strongest crosswise	50515	0·093
" weakest "	46221	0·076
Note.—The strongest lengthwise is the weakest crosswise, and *vice versa.*		
Table C. *Steel Bars.*		
Steel for tools, rivets, &c., strongest	132909	0·054
" " weakest	101151	0·108
" for other purposes, strongest	92015	0·153
" " weakest	71486	
Table D. *Steel Plates.*		
Strongest lengthwise	94289	0·0571
Weakest "	75594	0·1982
Strongest crosswise	96308	0·0964
Weakest "	69082	0·1964

Note.—The strongest and weakest lengthwise are also respectively the strongest and weakest crosswise.

*White Brass.** By M. Sorel.

A metallic alloy consisting of 10 parts of copper, 10 parts cast iron, and 80 parts of zinc, may be turned, filed, and bored, does not adhere to the moulds in casting, and retains its lustre for a very long time in moist air.—*Polytechnic Centralblatt*, 1859, p. 971.

* From the Lond. Chemical Gazette, No. 411.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, December 15, 1859.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Geographical Society, London, and E. S. Philbrick, Esq., Civ. Eng., Boston, Mass.

Donations to the Library were received from the Royal Geographical Society, and the Royal Astronomical Society, London; L. A. Huguet-Latour, Esq., Montreal, Canada; the Smithsonian Institute, Washington, D. C.; the Boston and Worcester Railroad Co., Boston, Mass.; the Virginia and Tennessee Railroad Co., Lynchburg, Virginia; J. Smith Homans, Esq., and B. F. Isherwood, Esq., Eng. U. S. N., City of New York; the Fulton Institute, Lancaster, Penna.; A. B. Cooley, Esq., the Hibernia Fire Engine Co., No. 1., and Prof. J. F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of December, was read.

The Board of Managers and Standing Committees reported their minutes.

Thirty-seven resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (9) were proposed, and the candidates proposed at the last meeting (17) were duly elected.

Nominations were made for Officers, Managers, and Auditors of the Institute for the ensuing year.

Resolved:—That the polls for receiving the votes of the members at the Annual election for Officers, Managers, and Auditors for the ensuing year, to be held on the third Thursday of January next, be opened at 3½ o'clock P. M., and closed at 8 o'clock P. M.; and that seven members be appointed by the President to receive the votes and report the results thereof.

R. Martin sent, through the Committee on Meetings, a sample of his patent metallic steam packing. It consists of a ribbon of woven hemp, rolled up into the form of a ring, whose inner diameter is somewhat greater than the rod intended to be packed, and whose outer

diameter is sufficient to fill the stuffing-box. About one-third of the ribbon is wound up, when a strip of prepared gum, sufficient to form a complete circle, is wound in with the coil; then, a strip of wire gauze is placed in the hole, and sewed, at its lower edge, with brass wire to the hemp; when the top edge is snipped at intervals, turned over the flat part, and the then outer corner of the coil, when the winding is resumed, and the gum enveloped by the hemp; which, when all wound has its end sewed to the body. Several of these rings are put into each stuffing-box, and they may, if required, be cut through in order to get them around the rod, though it is preferable to keep them entire. The gland need not be screwed down with a wrench, there being sufficient power in the fingers. It is claimed that the following advantages belong to this packing:—1st, A clear gain of power from reduced friction. 2d, It will not groove the sliding surface, but keep it perfectly smooth and bright. 3d, Durability, and consequent economy. That put in use has shown it to be entitled to the first and second claim; but, the length of time it has been in operation will not warrant an opinion upon the merit of the third claim.

Mr. A. F. Porter, the manufacturer, No. 420 Walnut Sreet, Philadelphia, has put it in use upon several engines in this City, and with uniform good results.

A spirit level for horizontal, inclined, and vertical operations, was exhibited by the Committee on Meetings. It consists of the usual tubes set into a brass piece of semicircular shape, which is contained in the block or main piece, also of brass. The block on the bottom part is shaped like a swallow's tail, with a flattening of the point, to give more bearing surface. The semicircular piece moves around a centre, and has its periphery graduated so that any number of degrees may be set. The use of the swallow-tail shape is, to obtain vertical points on a shaft by placing it astride, and striking a vertically sliding centre punch when the bubble indicates horizontality. This gives the starting points for key seats of cranks, when intended to be either in the same plane, or any required angle with each other. The instrument is nicely fitted, and will, no doubt, prove useful.

Mr. Robert Street exhibited his patent Fluid Gas Lamp. The body of this lamp is of the usual construction, but having a pipe leading from the bottom of the globe containing the fluid to the burner; within this pipe the wick is placed, which reaches to the bottom of the burner; the fluid is admitted to the wick by a stop-cock which regulates the flow. Attached to the burner is a mass of metal, which being heated converts the fluid into a gas and thus passes through the burner and furnishes the light.

Mr. Thomas E. McNeill exhibited and explained a model of his improved Sleeping Car for Railroad.

Mr. S. W. Hoffman showed to the meeting a model of his improvement in oiling the axles of railway cars and other carriages, and explained its mode of operation.

Detailed descriptions of Mr. McNeill's and Mr. Hoffman's patent, will be published in a future number of the Journal.

Abstract of Meteorological Observations for October, 1859, made in Philadelphia, Adams, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 60 feet. Prof. J. A. KIRKPATRICK, Observer.

1859. Oct.	Barometer. Mean.	Barometer. Mean daily range.	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
1	29·987	·144	65·2	22	8·0	·448	56	0·266	(var.)
2	29·885	·152	64·0	19	5·2	·384	62		W.
☽ 3	29·962	·117	62·0	20	3·3	·278	37		S W.
4	29·918	·039	66·3	29	5·0	·536	54		S W.
5	29·788	·175	68·0	25½	2·3	·486	47		N W.
6	29·858	·164	58·0	15	10·0	·215	35		N W.
7	29·941	·119	56·0	23½	3·7	·243	39		S W.
8	29·710	·231	66·7	25	10·7	·554	64	0·937	S W.
9	29·780	·086	51·6	14	15·0	·321	80	0·024	N E.
10	29·924	·143	49·7	16	4·7	·242	52	1·370	(var.)
○ 11	29·989	·065	56·7	25½	7·0	·332	50		N W.
12	30·051	·062	59·0	21	2·3	·366	52		N E.
13	29·933	·118	61·5	21	2·5	·416	57		S.
14	29·738	·195	66·2	21	4·7	·540	60		S W.
15	29·884	·146	53·2	17	13·0	·189	38		N W.
16	30·183	·299	48·7	17	4·5	·210	48		S E.
17	30·036	·147	55·5	20	6·8	·355	62	0·236	S.
18	29·668	·369	57·8	17	9·0	·311	56	0·084	(var.)
☾ 19	29·740	·103	47·3	14½	10·5	·146	36		N W.
20	29·693	·098	41·2	16	7·5	·159	53		N W.
21	29·752	·063	38·2	14½	4·7	·085	23		N W.
22	29·784	·032	39·7	18	1·8	·182	61		S W.
23	29·907	·157	45·2	14	5·5	·183	47		N W.
24	29·936	·111	48·0	22	3·5	·242	52		W.
● 25	29·586	·350	54·8	20	6·8	·284	48		W.
26	29·605	·069	36·7	10	18·2	·100	42	0·298	N W.
27	29·529	·114	35·8	11	3·5	·130	56		NNW.
28	29·693	·165	39·8	20	4·0	·146	47		N W.
29	29·829	·136	42·0	11	2·8	·159	53		N W.
30	30·015	·186	43·6	9	1·7	·129	40		N W.
31	30·024	·013	43·7	13	1·3	·142	42		N W.
Means	29·845	·140	52·3	18	5·9	·274	50	3·210	N75¼W.

GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 feet. Prof. M. JACOBS, Obs.

1859. Oct.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g. winds
	Inch.	Inch.	°	°	Inch.	Direc.
1	29·607	·168	63·3	1·7	0·009	S S W.
2	29·476	·181	61·0	3·0		S W.
3	29·596	·121	56·0	5·0		S W.
4	29·535	·062	54·7	4·7		S.
5	29·389	·146	62·0	7·3		(var.)
6	29·526	·188	54·3	7·7		(var.)
7	29·530	·096	51·0	6·0		S.
8	29·279	·251	62·8	11·3	0·145	S W.
9	29·350	·071	50·8	11·5		N E.
10	29·579	·229	49·8	8·0		N.
11	29·679	·099	56·0	6·8		W.
12	29·671	·022	56·3	2·3		S E.
13	29·548	·128	57·7	2·7		S W.
14	29·401	·168	61·7	4·0		W.
15	29·487	·094	50·5	8·2		(var.)
16	29·815	·329	50·0	4·2		?
17	29·662	·153	57·0	7·0	0·106	S W.
18	29·343	·319	42·0	15·0		(var.)
19	29·361	·135	49·8	8·5		.
20	29·234	·127	43·3	6·5		.
21	29·379	·145	40·3	8·7		.
22	29·366	·062	37·0	8·7	0·056	.
23	29·495	·193	45·3	8·3		. .
24	29·581	·213	45·7	1·0		?
25	29·236	·345	56·5	7·2		'
26	29·201	·101	38·7	14·5	0·300	N E.
27	29·142	·157	38·7	5·3		(var.)
28	29·327	·183	41·7	2·0		(var.)
29	29·478	·157	38·3	2·3		N W.
30	29·708	·227	40·0	3·0		N W.
31	29·696	·024	37·7	3·0		N W.
Means	29·473	·154	50·0	6·0	0·616	N88¼W.

SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.

1859. Oct.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds
	Inch.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	27·738	[illegible]	57·[illegible]	2·0	·497	83	0·037	W.
2	27·690	·048	54·3	4·3	·305	54		W.
3	27·758	[illegible]	55·3	5·0	·448	61		W.
4	27·740	[illegible]	59·7	4·3	·567	67		W.
5	27·658	[illegible]	58·7	4·3	·396	61		[illegible]
6	27·723	[illegible]	49·3	10·7	·262	59		N W.
7	27·678	·008	48·3	7·0	·300	48		S W.
8	27·494	·184	54·7	8·3	·429	77	0·058	(var.)
9	27·651	·157	46·0	8·7	·232	60		N.
10	27·704	·114	42·3	7·0	·236	54		N W.
11	27·829	·065	49·0	6·7	·345	54		W.
12	27·829	·023	55·3	6·3	·403	53		S W.
13	27·749	·086	57·3	2·7	·416	57		W.
14	27·611	·138	56·7	7·3	·458	75	0·054	(var.)
15	27·749	·138	41·7	11·7	·231	83		N W.
16	27·896	·147	44·0	10·3	·236	54		S E.
17	27·703	·179	53·0	9·7	·404	93	0·219	S.
18	27·533	·179	47·3	11·0	·212	63	0·430	W.
19	27·564	·141	42·0	7·3	·158	56		N W.
20	27·534	·135	36·3	8·3	·129	61		W N W
21	27·621	·094	33·0	4·7	·103	45		N W.
22	27·474	·147	34·3	3·3	·178	81	0·136	?
23	27·722	·248	38·0	7·0	·211	72	0·021	N W.
24	27·702	·085	43·7	11·0	·288	61		S.
25	27·427	·278	48·0	5·0	·288	61		N W.
26	27·280	·146	37·3	10·7	·177	66	0·200	S E.
27	27·338	·159	32·0	5·3	·121	59		W.
28	27·491	·153	33·3	1·3	·116	53		W.
29	27·660	·169	37·7	4·3	·073	24		WNW
30	27·803	·143	35·0	3·3	·165	72		W.
31	27·808	·040	34·0	1·0	·143	66		WNW
Means	27·652	·124	45·7	6·4	·276	62	1·155	N74¼W

Abstract of Meteorological Observations for October, 1859; made in Dauphin, Centre, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1859. Oct.	Harrisburg, Dauphin Co. 40° 16′, N. 76° 15′, W. Height, 300 feet. John Heisely, M. D., Observer. Barometer. Mean.	Barometer. Mean daily range.	Ther. Mean.	Ther. Mean daily range.	Rain and Snow.	Pre-vail'g winds.	Clo'ds, sky cov-ered.	Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs. Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail-ing winds.	Clo'ds, sky cov-ered.
	Inch.	Inch.	°	°	Inch.	Direc.	Per ct.	°	°	Inch.	Direc.	Per ct.
1	29·853	·200	67·0	1·7		E.	100	60·3	4·7	0·200	W.	100
2	29·748	·105	64·3	2·7		W.	37	57·0	6·7		W.	37
☽ 3	29·857	·109	62·0	2·3		W.	0	55·0	6·7		W.	0
4	29·788	·069	65·7	3·3		W.	0	58·0	5·0		W.	0
5						W.		63·0	5·0		(var.)	33
6	29·798		57·7			N W.	3	47·7	15·3		W.	0
7	29·822	·108	56·0	3·0		S W.	3	50·0	10·3		(var.)	20
8	29·558	·284	64·0	8·0	0·316	S E.	83	54·0	4·7	0·170	S E.	83
9	29·742	·184	51·0	13·0	0·100	(var.)	100	45·0	9·0		N E.	20
10	29·864	·121	52·3	4·0		N W.	10	43·3	7·0		(var.)	0
○ 11	29·946	·082	55·0	4·0		(var.)	17	47·7	4·3		W.	3
12	29·992	·046	58·3	3·3		S E.	27	51·3	3·7		(var.)	47
13	29·860	·132	62·0	3·7		S.	100	58·0	6·7		(var.)	40
14	29·647	·213	64·7	1·7		(var.)	37	56·0	8·7	0·100	(var.)	37
15	29·840	·193	54·3	9·3		N W.	10	43·7	12·3		N W.	17
16	30·113	·272	50·7	3·7		N.	3	43·7	8·0		(var.)	10
17	29·922	·191	53·7	5·0	} 0·230	S W.	100	52·3	13·3	0·110	W.	80
18	29·579	·343	58·0	8·3	}	N W.	67	51·0	6·7	0·375	N W.	77
☾ 19	29·671	·154	50·7	7·3		N W.	37	43·7	7·3		N W.	77
20	29·604	·134	44·0	6·7		N W.	53	36·0	7·7	0·025		
21	29·700	·106	40·3	4·3		N W.	0	33·0	5·0			
22	29·682	·018	40·3	2·0		W.	100	34·7	3·0			
23	29·886	·204	45·7	5·3		N W.	13	38·7	6·0			
24	29·864	·124	46·7	2·3		S W.	43	41·0	10·3			
● 25	29·491	·373	53·0	6·3		W.	27	46·3	5·3			
26	29·496	·041	35·3	17·7	1·000	N.	83	33·3	18·7	0·456		
27	29·434	·128	37·7	7·7		N W.	60	33·0	7·0			
28	29·606	·172	41·7	4·0		W.	77	37·0	4·0			
29	29·788	·182	48·3	1·7		W.	73	38·3	1·3		N W.	100
30	29·970	·182	44·7	1·3		N W.	100	39·3	2·3		N W.	100
31	29·958	·017	44·0	1·3		W.	63	39·0	1·7		W.	60
Means	29·769	·154	52·1	5·0	1·655	N 69¾ W	47	46·1	6·9	1·436		

1859. Oct.	Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 feet. W. B. Hildebrand, Obs. Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Pre-vail'g winds.	Clo'ds, sky cov-ered.	Tarentum, Allegheny Co. 40° 37′ N. 79° 46′ W. Height 950 feet. J. H. Baird, Obs. Thermometer. Mean.	Thermometer. Mean daily range.	Prevail-ing winds.	Clo'ds, sky cov-ered.
	°	°	Inch.	Direc.	Per ct.	°	°	Direc.	Per ct.
1	60·0		?	N.	87	58·0	5·7	W.	83
2	56·0	9·3		W.	33	53·7	7·0	(var.)	10
☽ 3	54·0	5·3		(var.)	7	54·7	4·3	W.	0
4	60·0	6·0		S W.	0	64·3	9·7	W.	0
5	62·3	4·3		(var.)	23	60·7	9·0	(var.)	20
6	42·7	19·7		N E.	10	45·3	12·3	(var.)	23
7	50·0	14·0		N W.	60	49·0	10·0	(var.)	57
8	52·3	5·3	0·280	(var.)	100	50·3	5·3	N W.	97
9	45·3	7·0		N.	23	44·0	6·3	(var.)	23
10	41·3	4·0		(var.)	0	43·0	3·7	S W.	3
○ 11	46·0	4·7		(var.)	13	47·7	4·7	(var.)	10
12	54·3	8·3		[illegible]	50			W.	23
13	58·3	6·0		S.	53	52·7		S W.	23
14	56·7	9·0	0·400	(var.)	50	55·3	10·0	(var.)	43
15	42·7	14·0		W.	3	43·0	12·3	(var.)	18
16	48·3	12·3		S E.	33			?	0
17	56·7	11·0	0·600	S E.	100	58·3		S W.	83
18	48·0	11·3		W.	90	49·0	14·3	W.	93
☾ 19	43·0	7·0		W.	70	46·0	5·7	W.	73
20	35·3	8·3		N.	53	38·7	7·3	N W.	53
21	32·0	5·3		(var.)	27	35·0	5·0	(var.)	40
22	35·3	3·3	0·110	(var.)	100	36·3	2·7	W.	100
23	40·0	4·7		N W.	63	39·7	4·0	S W.	70
24	42·3	4·3		S W.	53	41·3	5·0	S W.	17
● 25	46·3	5·3		N W.	43	46·3	6·3	W.	23
26	34·7	11·7		E.	97	36·3	10·0	(var.)	100
27	33·0	4·3		(var.)	67	35·0	4·0	W.	78
28	33·7	1·3		W.	73	38·3	3·3	W.	100
29	35·0	2·0		W.	73	40·7	2·3	W.	87
30	36·0	1·0		N W.	100	38·0	2·7	S W.	97
31	35·3	0·7		N W.	97	38·3	0·3	W.	100
Means	45·7	7·1	?	N 80° W	54	46·2	6·1	S 88½° W.	50

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

FEBRUARY, 1860.

CIVIL ENGINEERING.

Steam Engineering in 1859.* *Application of Steam as a Motive Power.*

(Continued from page 12.)

In the remarks on Steam Generation, when referring to the evaporative duty of 1 lb. of coal, the temperature of the feed water has been unintentionally omitted; and to prevent misconception, and give the said remarks the value due to them, it is only necessary to explain, that in all cases 100° is assumed as the feed temperature, for the reasons that this accords with the general working of condensing engines, and has been adopted by the Admiralty as the temperature of the feed in their experiments.

Before leaving this subject, it will be well to remember that the utmost saving which can be realized by supplying the boilers with water having a temperature of 212° instead of the usual temperature of 100°, does not exceed 10½ per cent.; many disappointments would be spared if this fact was more generally known and respected.

It may also be explained, that fully admitting an increase of the total heat in steam as it increases in pressure, yet, for the sake of simplicity, all the evaporative statements and comparisons have been made at an assumed atmospheric pressure. In general practice, excluding locomotives, the working pressures on land and sea may be included within 15 lbs. and 45 lbs. per square inch (above the atmosphere), and the additional total heat in steam of 45 lbs. per square inch as compared with that of 10 lbs. is, according to the best authorities, about 7·4°; this is equivalent to a loss of evaporative duty in generating the higher pressure of scarcely ¾ per cent., and this loss will be increased slightly by the increased radiation.

*From the Lond. Artizan, Aug. 1859.

In the case of the locomotive, with say a pressure of 150 lbs. per sq. inch, the total heat is about 33° in excess of that of 15 lbs. making a difference in evaporative duty of scarcely 3 per cent. in favor of the latter. It is quite evident, therefore, in comparing evaporative duties under moderate and usual pressures, it is for general purposes unnecessary to notice the difference arising from the varying total heat in steam of different pressures.

After considering the present state of steam generation as regards evaporative duty and economy, it is necessary before passing from the boiler to the engine, to ascertain in what condition steam is supplied and conveyed from the generator to the cylinder.

In land boilers, where space can easily be obtained, steam capacity sufficient to prevent priming is readily insured; but at sea it is often most difficult in a multitubular boiler to supply steam without an undue amount of water in combination with it.

Among the main causes of priming, are contracted water surface, irregular local evaporation, insufficient steam space, and position of steam exit. The first prevails chiefly in cylindrical tubular boilers; the second more or less in all multitubular boilers; whilst the third and fourth may be found in all kinds of boilers.

Unless positive inconvenience arises, the presence of an undue amount of water with the steam is not readily ascertained. Violent action in the gauge-glass, water in the cylinders, and sometimes loss of vacuum, are almost the only signs of priming; but there can be no doubt, all these symptoms may be wanting, and yet the steam supplied be accompanied with an excess of moisture.

Without superheating the steam (which will be referred to in due course), it is essential in avoiding any unnecessary loss of heat to supply it with the moisture due only to its pressure and sensible temperature.

Unfortunately, there is no reliable information on which to determine the amount of heating surface required in the steam space; but it must be evident it should be more or less, according to capacity, area of water surface, and all those other conditions determining the priming or non-priming qualities of a boiler.

The supply of pure steam is a great desideratum, though seldom obtained; little or no anxiety is expressed on the subject, except in extreme cases, when the palpable inconveniences before referred to compel the engineer to supply a remedy.

And now a word respecting the transit of the steam from the boiler to the engine.

On land, as a general rule, there is a considerable length of steam piping between the boiler and the engine; frequently this piping is unclothed, and even when clothed the condensation therein is considerable.

In a Cornish mine, steam power was required under such circumstances, that an unusually long steam pipe was necessary: this pipe was unclothed. The day arrived for setting the engine to work, but it was found impossible to supply sufficient steam to drive the engine alone.

The boiler was of the usual description and size for the power; and the failure could not at first be accounted for, but on disconnecting the steam pipe from the engine, it was found that the condensation of the steam in transit was sufficient to abstract $\frac{3}{4}$ of the heat in the steam; as a remedy, the steam pipe was enclosed in a flue, kept at a temperature equal to the sensible temperature of the steam; the result was in every way satisfactory, there being a pressure of 40 lbs. in the boiler and 37 lbs. in the cylinder.

This is an extreme case; but the bulk of factory engines lose a large per centage of their power by similar condensation, which mere felt and canvass or wood will reduce, but not prevent. In marine engines, with thin copper piping (generally placed under the hatchway, supplying the cold air to the boiler furnaces), the temperature of the felt and canvass covering indicates plainly the combat going on between 250° inside, and 70° outside. The result is an addition to that condensation, the presence of which every engineer must deplore; and the cylinders are supplied with steam of a different and less valuable character than that generated.

One reason why this, to a great extent useless, condensation exists is ignorance of its exact amount, and often also of its effect in the cylinder, to which we shall refer anon. What would be said of the engineer who supplied his furnace with a constant stream of cold water, or who arranged a shower-bath on the top of the boiler? and yet to produce the effect of such arrangement is the daily orthodox practice of the steam engineer. He readily recognises the difficulty of absorbing the latent heat, and producing a cubic inch of water from steam in the condenser; whilst, at the same time he is often practically indifferent to the formation of water in the steam-pipe.

Time and experience will undoubtedly show the importance of conserving to the utmost the heat of the steam in transit from the boiler to the engine; and where circumstances require an exposure of the steam-pipe, it will be found that, to avoid a loss more than due to condensation *per se*, it is necessary, by some means, to preserve the working steam at its full temperature and pressure, and arrange that whatever loss of heat and condensation are unavoidable should take place apart from the working steam, in maintaining its temperature and pressure.

Are engineers and users of steam-power alive to the importance of supplying steam engines with uncondensed elastic steam? We think not, or so many unclothed steam-pipes and cylinders would not be found in use, the former frequently inclined towards the cylinders, so that all the water resulting from condensation is obliged to pass through the engine to the condenser.

Since steam was first employed as a motive power, there has been a constant yearning among engineers for a simple engine, having few moving parts, and those comparatively frictionless; hence the various schemes for rotary, oscillating, and other simple engines; and we have the result of these efforts in the almost perfect specimens of mechanism now produced by our first engineers of the present day.

If a knowledge of, and attention to, the science of steam-power had kept pace with the progress and improvement in the mechanism for producing and applying the same, steam engineering in 1859 would not be in such a defective state, nor would there be such a serious difference between the actual and possible results.

All steam engines may be divided into two classes—beam or lever, and direct-acting; and in every kind of steam engine there are two distinctive arrangements affecting the duty realized: the first is the conveyance, use, and disposal of the steam, and, secondly, the mechanism by which the steam pressure is transmitted to the resistance to be overcome.

The pressure and power of the steam being entirely dependent upon its temperature, it follows that the first point to be insured is the preservation of this temperature.

Boiler supplies Cylinder with a certain amount of steam, containing so many units of heat available for power; what does Cylinder get out of this steam? Why, in the first place the reception is most chilling, steam parting with much of its heat in warming Cylinder. Generous Boiler makes good the deficiency, until the door is closed, say at $\frac{1}{4}$ of the stroke, when, $\frac{1}{4}$ only of Cylinder being warmed, the remaining $\frac{3}{4}$ robs the expanding steam, now cut off from Boiler, of a further amount of heat. Cylinder having now got all it can out of steam No. 1, opens the back door, and begs it to make itself scarce, and walk into the condenser, so as not to impede the entrance from boiler of steam No. 2, on the other side of the piston. Directly the water accompanying the exit steam breathes a vacuous atmosphere it begins to evaporate, robbing Cylinder of nearly the whole of its ill-gotten heat derived from steam No. 1; and, not satisfied with this, insists on injection converting it, for the *second* time, into water. These unfriendly acts prevent steam No. 2 from deriving the advantage it had a right to expect from heat supplied to Cylinder by steam No. 1.—*Nolens volens*, steam No. 2 has to re-warm Cylinder, receive the extra supply during admission from boiler until the door closes, and then continues the heat-losing process until, like No. 1, it arrives at the end of the stroke in a most reduced condition, and, as the back door opens, rushes, with its companion water, into the condenser, to give further trouble to injection and pumps. After working thus for some time, Cylinder stops, and Boiler begs leave to have the accounts looked into. Such a reasonable request cannot be refused; but after considerable discussion, no balance can be made. Boiler says to Cylinder, "I supplied you with 1000 cubic feet of steam, which, if rightly employed, should give a duty according to the heat therein, whereas the duty realized is not equivalent to an expenditure of 700 cubic feet; what have you done with the missing 300 ft.?" Cylinder then confesses, with tears (condensed steam), that somehow or other it had borrowed a little heat from steam No. 1 to warm itself, and, at the end of the first stroke, felt quite comfortable, and was in a position to return to steam No. 2 the borrowed heat; but directly the back door was opened, the water left with the steam, as the result of the heat abstracted by the Cylin-

der evaporated, and took in to the condenser nearly all the heat that the Cylinder had borrowed from the steam.

After this confession, Boiler proposed one remedy, and Cylinder another; the former said to Cylinder, "I have more heat in my flues than I require (awkward confession), and will give such an extra supply to the steam I furnish you with, that after you have appropriated as much as you require to keep yourself hot, there will be sufficient left to prevent any condensation."

This remedy was tried, and the result was that on all occasions no difficulty was experienced in making a balance. It is but fair, however, to state that Cylinder (this time without tears and with a dry skin) was overheard to remark, that, "since Boiler's remedy had been in force, it was too much of a good thing," and "he had now more heat than he wanted," and "that he couldn't stand it long without losing flesh."

Cylinder's remedy was to keep itself supplied with, and constantly wear a hot jacket, sufficient to keep him at a constant temperature, and prevent stomachic condensation, and after trying this plan Cylinder seemed quite comfortable, and soon saved the cost of the hot jacket.

The above, omitting the remedies, fairly represents the state of affairs in all condensing engines, and is another straw, and rather a large one, on the camel's back.

Water boils in a pure vacuum at a temperature little in excess of that of the atmosphere of an engine room—so that whatever condensation takes place on the admission of the steam to the cylinder, the water resulting therefrom, is invariably of such a temperature, as to be converted into vapor when brought into communication with the condenser; thus this steam is twice generated and twice condensed.

Nor is this diseased condition confined to condensing engines, but exists to a considerable extent even in the locomotive, except when the cylinders are maintained at a temperature equal to that of the working steam by being placed in the smoke-box or flue.

In a Paper read before the Members of the Institution of Mechanical Engineers, by Mr. D. K. Clark, in 1852, it was shown that in engines with outside cylinders, the condensation therein amounted to 20 per cent. of the total steam used, when it was cut off at one-third, or expanded twice. The greater the expansion the greater the per centage of condensation.

In all cases with clothed or unclothed cylinders, when circumstances have admitted of a comparison between the amount of water evaporated and of steam used, a considerable loss by condensation in the steam pipes and cylinder has been detected, in some cases to an extent of 40 per cent.

Again, it has been found that 1 lb. of coal expended in heating the cylinder is equivalent in effect to five pounds of coal burnt in the furnace of the boiler.

Again, the amount of heat required to keep the cylinder at the temperature of the working steam, has never been found to exceed 10 per cent. of the total heat expended, and in many cases has been less than 5 per cent., whilst with an expansion of four or five times, the jacket

expenditure of 5 per cent. realizes an increased duty of not less than 25 per cent.

Again, the injection and air-pumps can be reduced fully one-fourth, when means are adopted to prevent condensation in the cylinders.

It may be added also that the evil effects of water in the cylinders at starting are never experienced, when the cylinders are properly heated.

Watt patented the heated jacket in 1769, and in 1859 not one per cent. of the engines in use, have any arrangements for maintaining the temperature of the working steam, engineers being practically indifferent to the waste such neglect occasions.

Can one heated cylinder be found in her Majesty's steamships of war? if not, will the great men who supply our marine engines to the steam navy, condescend to inform the engineering public why, with their extensive connexion and influence, they are, in 1859, so silent on this important subject? will they not have compassion on us, and prove that they are right in ignoring the maintenance of heat in working steam?

Will the designers of the machinery of the *Great Eastern* explain why a trifle of £2000 or £3000 was not expended in ascertaining the truth or fallacy of the alleged economy of such a simple improvement as heating the cylinders?

The remarks on expansion, &c., must be left to the next number.

(To be Continued.)

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*An Improved Method of Retarding and Stopping Railway Trains.**

By Alexander Allen, Engineer, Perth.

In the prevention of collisions, and their consequently serious results, a few seconds are most valuable: the danger also is, in most cases, first seen by the man in charge of the engine. The object of these improvements is, therefore, to give the driver increased power of controlling

* From the Lond. Mechanics' Magazine, November, 1859.

the speed of, and in stopping the trains; and for this purpose, and in order that the whole brake power of any train may be brought into requisition in the shortest possible time, it is recommended that, in addition to the apparatus to be hereinafter described, a cord shall be placed within convenient reach of the men on the engine, communicating with a bell fitted up in the first brake-van, by which means the guard may be apprized of his assistance being required at the van-brakes.

The improvements consist of two distinct parts. 1st. By inserting a throttle or other valve in the exhaust-pipe of the engine at A, so that by means of a connexion B the driver can fully or partially close the valve A. By the table of experiments appended, it will be seen, that by the closing of this valve (the regulator being at the same time open), a retarding force is opposed to the engine of equal power with the tender brakes, and for all *ordinary* stoppages this can be used to bring the train almost to a dead stand—the tender brake being applied only for say the last dozen yards, thus effecting a great saving in the permanent way, tender-tyres, and brake-blocks.

The second part of the improvements consists of a steam brake to work in connexion with the above valve in cases of great danger. The steam is taken from the exhaust-pipe by means of the pipe C, which is supplied by a stop-cock or valve V, worked from the foot-plate by the connexion D, which being separated from the connexion B, it will be seen that one or both of the retarding forces may be used at pleasure. The steam from the pipe C passes to cylinder E, actuating the piston H and levers K, &c., and brake-blocks N, which may be applied to all the wheels if desired, but by preference they are shown attached to the leading and trailing wheels only of passenger engines. On the steam being released, the weight of piston, rods, and levers will free the brake-blocks from the wheels.

By partly closing (more or less) the throttle-valve, trains may be controlled when passing down steep inclines to any desired speed, leaving in reserve (in the case of heavy goods trains especially) a great surplus of brake-power to bring the train to a stand quickly on any incline—namely, that of the steam-brake herein described, and also that of the tender and van-brakes. In illustration of this, an experiment, not included in the table, resulted as follows:—On an incline of five miles, the gradients averaging 1 in 80 (descending), and with a gross load, estimated at 200 to 210 tons, the throttle-valve alone controlled the train from a starting speed of thirty miles per hour to fifteen miles per hour over the whole distance.

The partial closing of the valve may also be made to prevent violent slipping, as the wheels will only revolve in proportion (*i. e.*, the traction will only be equivalent) to the quantity of steam allowed to escape from the exhaust-pipe, and this may be regulated to any extent by the valve, which can be worked with greater ease and nicety than the regulator.

With regard to reversal, it is known to be extremely difficult, if not impossible, to reverse an engine at speed, but it will be seen that, with

full steam on the pistons, the closing of the throttle-valve, which is not effected by speed, produces a result quite equal to that of reversal, whilst reversal itself is facilitated by a greater equalization of the pressure on both sides of the valves, and an increased brake-power is obtained (see Table) without the usual objectionable results of reversing the engine whilst in motion.

The combined effect of these appliances may further be shortly stated to be,—

1st. By the throttle-valve alone a power is exerted equal to that of the tender-brakes.

2d. By use of the tender-brakes in combination with the above, a doubling of this power is obtained.

3d. By using the engine's steam brake-blocks, the throttle-valve, and the tender-brakes together, a retarding power equal to triple that of the tender-brakes alone is brought out.

4th. In addition to the above, by reversing, this retarding power is still further increased, and

5th. By the recommended communication from the engine to the van, used in combination with the whole, a power of stoppage is obtained, which has not hitherto been equalled, and within much less time. This last is the most important element, as all necessary manipulations can be gone through in one or two seconds after their requirement being noticed.

TABLE.

Abstract of experiments with a gross load of 85 tons, made up as under:—

Engine, . . .	18 tons.	85 tons.	Weather calm; rails dry.
Tender, . . .	12 "		
Eleven empty carriages, .	55 "		

Gradients.—The first ¼ mile from the post at which the brake-power was applied was level. The next ¼ mile further, 1-500ths rising gradient. In every case, the retarding force was applied at the same mile-post on the same line of rails. The carriage-brakes were not applied in any case.

Number.	Seconds to ¼ mile.	Miles per hour.	Seconds to stop in.	Distance run. yards.	Class of Brake, and Remarks.
1	25	36	156	1432	No brakes applied.
2	25	36	80	800	Throttle-valve only used. Valve leaky did not bring the train to a *dead stand.* Speed was very slow for the last ⅛th of a mile.
3	25	36	66	715	Tender brake only.
4	24	36½	63	710	Throttle valve closed, and engine reversed.
5	25	36	50	460	Throttle valve closed, engine reversed, and tender brake used
6	25	36	55	450	Throttle valve closed, and tender brake used.
7	25	36	50	400	Throttle valve closed, and engine steam brake applied.
8	25	36	30	275	Throttle valve closed; engine steam brake and tender brake applied.
9	25	36	23	220	Throttle valve closed; engine reversed, steam brake and tender brake used.

NOTE.—The results as per table were obtained from an engine with the throttle valve and steam brake fitted up only in a temporary manner. With the apparatus more perfectly applied better results would necessarily be obtained.

For the Journal of the Franklin Institute.

Description of a Triangular Ring-joint used on the Camden and Amboy Railroad. By John C. Trautwine, Civ. Eng., Philada.

To the Editor of the Journal of the Franklin Institute.

The accompanying sketch represents a triangular ring-joint, which has been in successful use for seven or eight years on portions of the Camden and Amboy Railroad between Philadelphia and New York. A recent examination of some of these joints, which have been, for about three years, traversed daily by from 20 to 30 freight and passenger trains drawn by heavy engines, has so fully convinced me of their merits as to induce me to submit to you a brief description of them. It is probable that this joint may furnish hints for further improvements, and, perhaps, lead to something superior to any of the joints and chairs now in use. It was devised by Edwin A. Stevens, Esq., who was for many years superintendent, and is now president of the road.

The *circular* ring-joint, which was made on essentially the same general principle, was found liable to the objection of *revolving* under the action of the trains, and thus greatly expediting the loosening of the wooden wedges by which it was confined to the rail. This difficulty is obviated in the present joint, which is fully shown in the accompany-

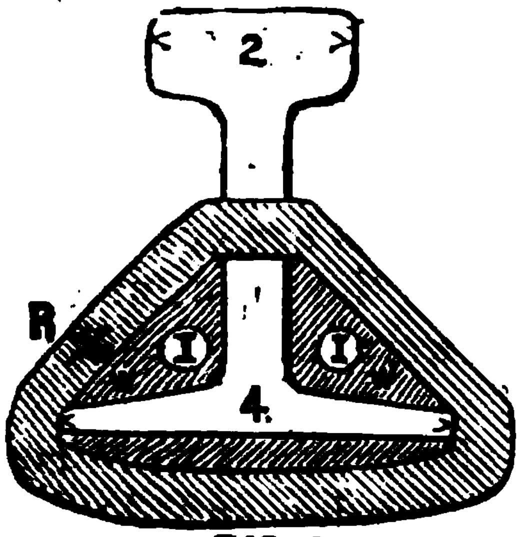

FIG 1.

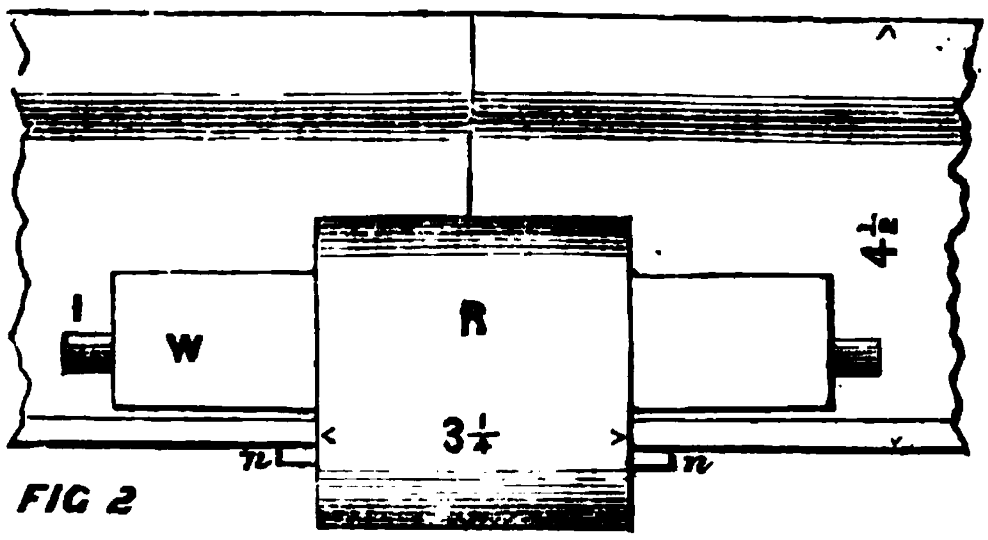

FIG 2

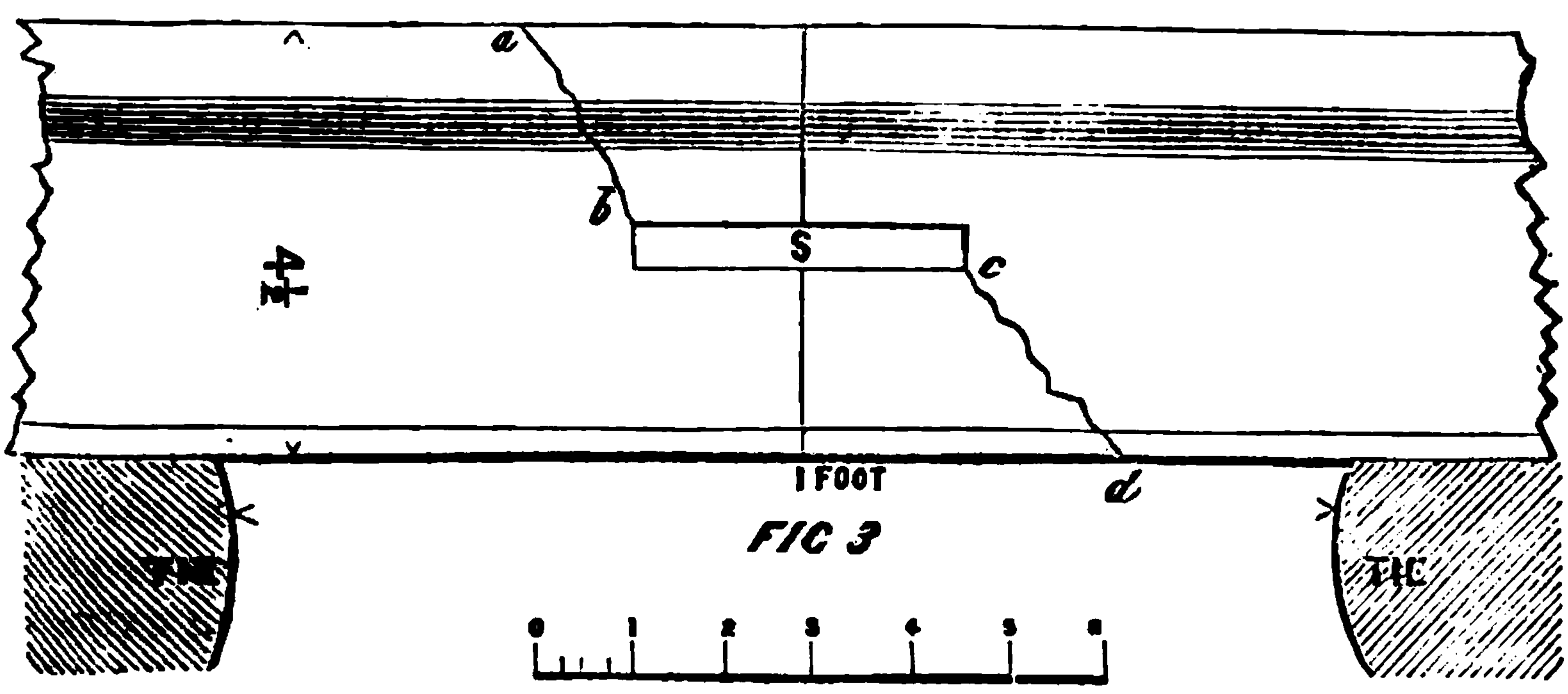

FIG 3

ing sketch drawn to one-fourth its real size. Its construction is very simple, consisting merely of a continuous nearly triangular ring or sleeve, R, of wrought iron, Figs. 1 and 2, 3¼ inches wide, and ½ inch thick. The top of this ring passes through a slot, S, Fig. 3, cut out

of the ends of the rails; and, after being fixed in its position, two cast iron wedges, w w, Figs. 1 and 2, 7½ inches long, and with a very slight taper, are driven between the sides of the ring and those of the rail. These wedges being liable to break are strengthened by rods of wrought iron ⅝ of an inch in diameter, and 8½ inches long, inserted as a core when the wedges are cast. A thin wedge of plate iron is also driven in, under the rail.

The joints are placed, not *over* but *between* the cross-ties; the distance apart of which is there diminished to about one foot in the clear, Fig. 3.

This is not only the most simple and cheapest joint that I have seen, but, so far as I can judge from that portion of the road which I have examined carefully, one of the most effective. As before remarked, the ring-joint on that portion has for about three years sustained the traffic of about 25 trains daily, drawn by heavy engines; yet the joints are in so perfect a condition, and the ends of the rails so free from bruises and splits, that I at first thought they had been laid but a few days. The weight of the rails is about 65 ℔s. to a yard; and I observed that where the same rail had been laid for the same length of time, and had endured the same traffic, but with very heavy cast iron joint chairs resting on the cross-ties (instead of the ring-joint), the ends of the rails were bruisėd, and the joints comparatively uneven.

In close proximity to the foregoing and under the same general circumstances, is the 91 pound rolled rail, with strong wooden fishing beams at the joints (similar to what is known as Trimble's joint), and also devised by Mr. Stevens about 15 years since. This rail has worn much more rapidly than the smaller one, and its ends are considerably bruised; while those of the 65 pound rail laid with the triangular ring-joint, are almost as perfect as on the day they were laid, about three years ago.

Again, at the point at which the foregoing observations were made, the Camden and Atlantic Railroad crosses the Camden and Amboy.

The rail of the former road is the inverted ∩; and its joints are connected by an inverted ⊥ chair of rolled iron, 5 feet long, with 4¾ inches width of base; the base being ½ inch thick. This chair rests on three cross-ties, the middle one of which supports the ends of the rails. Although the traffic over this chair is very trifling in comparison with that over the ring-joint of the Camden and Amboy road, yet it has sufficed to show that owing to the rigidity of the former the ends of the rails are exposed to more rapid deterioration than with the ring: it is probable, however, that the difference is partly due to the inferiority of the ∩ rail itself. I am of opinion that the ⊥ joint would prove much more serviceable if the ends of the rails met *between two* cross-ties, instead of resting *upon one*. It holds the rails in place extremely well, and certainly possesses much merit; but it is very expensive.

The triangular ring-joint is not free from defects. Its wedges loosen and require frequent re-driving, as is always the case where such wedges are used with rail chairs. This, however, is a consideration of but little importance; and the track men find this joint to require much less

attention than chairs with wedges. A more serious one is, that where the foundation on which the cross-ties rest is bad, and permits much unequal settlement, the increased strain thereby brought upon the ends of the rails and upon the ring-joints, occasions a tendency to split off a portion of the end of the rail either above or below the slot, as shown by the lines *a b* and *c d*, Fig. 3. Very nearly all break *below*, along *c d*.

This can be avoided only by careful attention to maintain the constant adjustment of the track. It has taken place to but a limited extent on the Camden and Amboy road, and fortunately is not attended by any danger to trains. The taking up of a rail and replacing it by another, with the ring-joint, is an operation of no more than the ordinary labor involved in the process of changing rails. The engines and trains pass over the joint very smoothly, without any perceptible jar or noise.

The rings are formed on a mandril of the required shape.

For some of the foregoing facts I am indebted to the kindness of Col. William Cook, Chief Engineer of the Camden and Amboy Railroad; and it affords me pleasure to add that he fully concurs with me in considering the triangular ring as being the best of the many joint fastenings and chairs that have been so thoroughly tested on that important work. He is extending its use upon the road, as fast as the necessity for laying new rails permits him to do so.

With some simple device for preventing the loosening of the wedges, and the breaking of the rails, this joint would leave little to be desired. Perhaps the former might be attained by using *wrought* iron for the side wedges w w; the smaller ends of which might be suddenly tapered off, so as to be readily bent outwards a little, after being driven, and the latter, by the use of longer and stouter bottom wedges.

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*Straightening a Chimney Stack.**

The operations for restoring the colossal chimney at Port Dundas to a perpendicular and safe position, are now successfully completed. This was accomplished by sawing several of the mortar beds between the courses on the side from which the chimney leaned, thereby allowing it to come back by its own weight, without the application of any external force. Only one draft was cut at a time, to guard against any shock which might have endangered the stability of the building, and by keeping the saws wet, a bed of mortar was prepared for the superincumbent weight to settle down upon. Twelve cuts were made in this manner, on different parts of the structure, which generally set before the saws had passed through half of the circumference, particularly in those made nearest the ground where the weight was greatest. This method, which has been attended with complete success, was adopted by the advice of Mr. Duncan Macfarlane, architect. The principal dimensions of the chimney are:—Total height, 468 feet; from surface to top of cope, 454 feet; outside diameter at foundation, 50 feet; at surface, 34 feet; at cope, 14 feet.

* From the London Civ. Eng. and Arch. Jour., Nov., 1859.

AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED FROM NOVEMBER 1, TO NOVEMBER 29, 1859, (INCLUSIVE,) WITH EXEMPLIFICATIONS.

NOVEMBER 1.

1. CUT-OFF VALVES FOR STEAM ENGINES; E. R. Arnold, Providence, Rhode Island.

Claim—1st. Making the tappet and the ends of the jointed valve rods, inclined in a direction at right angles to their lines of motion, and combining them as set forth. 2d, The combination of the regulator with a tappet, constructed as described.

2. SHIRTS; L. S. Ballou, Jr., City of New York.

Claim—A shirt, formed by having its yoke made of two pointed projections, extending down from the shoulders or inclined front ends of the yoke, on the shoulder blades of the wearer, in such a manner as to leave a recess between the projections, which recess extends upward nearly to the neckband.

3. RAILROAD CAR COUPLINGS; H. A. Barnes, Milwaukie, Wisconsin.

Claim—The arrangement of the latch in the draw-head, in combination with the cam, latch, or hook connexion, lever, or treadle, in the manner described.

4. METHOD OF PROTECTING TELEGRAPHIC INSTRUMENTS AGAINST ATMOSPHERIC ELECTRICITY; E. F. Barnes, Brooklyn, New York.

Claim—The application and use in a telegraphic line, or in connexion with telegraphic instruments, of a vessel, containing acidulated water or fluid, and having a platinum or other metallic wire of better conductibility than the contents of such vessel passing through such vessel, and connecting by one end with the main wire, and by the other with the telegraphic machine. Also, in combination or connexion with such vessel of fluid and wire, the arrangement of the metallic points on the wire of the main line, and extending into the fluid.

5. MACHINES FOR PACKING FLOUR IN BARRELS; J. Bartholomew, Union, New York.

Claim—1st, The combination with the packing screw, or its equivalent, of a cylinder, or its equivalent, so that the flour will be first packed within the said cylinder, or its equivalent, and then discharged therefrom, in a packed state into a bag, barrel, or other receptacle. 2d, The arrangement of the rod, levers, Q K, block, connected with the shaft by the cord or chain, and the hub or boss on screw-shaft, for the purpose of automatically discharging the packed flour from the cylinder or measure. 3d, The arrangement of the lever, D, with pinion, attached block, hub, or boss, levers, O P, and spring, for the purpose of automatically discharging the pinion from the wheel, and thereby stopping the rotation of the screw at the proper time.

6. COFFEE-ROASTER; R. L. Bate and James Caulkins, Adrian, Michigan.

Claim—The combination of the stationary cylindrical chamber, revolving skeleton stirrer, and outer vertical cylindrical casing, constructed as set forth.

7. RAILS FOR RAILROADS; G. W. R. Bayley, Brashear, Louisiana.

Claim—The reversible Z rail for railways, that is to say, the rail with its stem placed inside of the vertical centre of its head, outside of the vertical centre of its base, with the inner and outer portions of its head and of its base of different thickness and form, with its head and its base similar in transverse section as to outline, though reversed as to relative position and connexion to the rail stem; the stem being nearest to the inside thick lip of the rail head, and to the outside thick lip of the rail base, while the thin lip of the rail base is inside, and the thin lip of the rail head is outside.

8. COTTON GINS; Benjamin G. Beadle, Memphis, Tennessee.

Claim—Uniting the knuckles or projections on the ribs, by a back or brace extending through the series for the purpose of strength, and for keeping them in proper position.

9. FARM FENCE; T. G. Beecher, Beaver Dam, New York.

Claim—Combining with the posts, arranged as described, the rails made removable and replaceable by means of the locking device.

10. ARRANGEMENT OF DEVICES IN SHINGLE MACHINES; W. H. Bitser, Muscatine, Iowa.

Claim—The arrangement of the frame and planer upon the self-adjusting swinging bar, and the combination of the parts thus arranged with the pivoted lever and reciprocating carriage, as described.

11. SEWING MACHINES; Wm. G. Budlong, Hartford, Connecticut.

Claim—The combination of the adjustable groove segment with the looper bar fitted loosely therein, feeder arrangement, operating rod, having cams secured thereto, and connected by arms, arranged in the manner described.

12. SCALE FOR CUTTING BOOTS AND SHOES; S. F. Burdett, Keokuk, Iowa, and Henry Still, Leavenworth City, Kansas Territory.

Claim—1st, The lines of average ankle, heel, instep, and ball measures, running from the point "A," or any other given point that will produce the same result, with the lines of increase and decrease intersecting them at such an angle, and at such a distance from each other as will produce the purpose set forth. 2d, The device of so arranging the heel and instep measures, that any required size of said heel and instep may be marked at one stroke with or without the combination of the average measures of the same. 3d, The one-third of an inch increase and decrease of average heel measures upon the different lengths of lasts, or such portions of an inch as will produce the same effect.

13. WATER-METRES; Levi Burnell, Milwaukie, Wisconsin.

Claim—The arrangement of the hollow arbor with a narrow slot, in combination with the lips formed by the inner edges of the buckets.

[This invention relates to that class of water-metres in which a bucket wheel is employed, which is caused to rotate by the gravity of the water as it enters one of the buckets after the other. The water enters the buckets through a narrow slot in the arbor around which the bucket wheel rotates, and the inner edges of

the buckets form lips which cut off the water from each bucket as soon as the same is filled, and cause the str am to pass into the next succeeding bucket. Each bucket is caused to fill to the exact height by means of a counterpoise, whereby the water is measured correctly and also weighed at the same time.]

14. Washing Machine; Robert H. Champlin, East Greenwich, Rhode Island.

Claim—The combination of the rounds or slats and springs with the cylinder, constructed as described

15. Electro-magnetic Burglars' Alarm; Edward C. Clay, Malden, Massachusetts.

Claim—The combination in an electric burglars' alarm of a galvanometer, with a resistance coil and an automatic switch, for the purpose of indicating the point where a burglar is attempting to effect an entrance. Also, the combination in an electric burglars' alarm of a galvanometer and a bell, with suitable mechanism to ring it, for the purpose of simultaneously giving an alarm and of indicating the place of attack. Also, the use in a burglar alarm of a regulating coil, in combination with the resistance coils, for the purpose of maintaining a constant relation between the strength of the current and the varying resistance of the circuit, when the respective resistance coils are included.

16. Projectiles for Ordnance; J. W. Cochran, City of New York.

Claim—Constructing and combining the body of the projectile and its shirt or case of soft metal, so that the passages for the gases of the exploded powder are formed partly in the body of the projectile, and partly in the shirt or case, with their entrances in the shirt or case, without perforating the body of the projectile; and that the shirt can be carried separately from the body and slipped on when required for use, in such manner as to remain secured thereon during the flight of the projectile.

17. Slide Valves of Steam Engines; Nathan Cope, Cincinnati, Ohio.

Claim—The combination with the valves of the grooves and notches, as set forth.

18. Electrotype Printing-blocks; Thomas Crossley, Rockville, Connecticut.

Claim—An electrotype printing-block for printing fibrous and textile fabrics, which is prepared from a mould formed of at least three diff rent lengths of type, so as to have a highly raised printing-face, composed of metal margins surrounding a felt or other equivalent ductile or plastic substance, to lift or carry the color.

19. Meat-slicer; Bradford Dean, Clayville, New York.

Claim—The arrangement of the knives, I and I′, knives, D and D′, and the adjustable guide, as described.

20. Steam Engines; James Cumming, Boston, Massachusetts.

Claim—1st. The combination with a square piston chamber, of a square piston, which is constructed of a series of angular sections of packing, joined loosely together by lap joints, and made adjustable and kept steam-tight. 2d, In combination with the above, the use of a square piston rod and a square stuffing-box, in the manner set forth.

21. Stave-jointing Machine; John K. Derby, Jamestown, New York.

Claim—1st. The employment of two conical cutter heads provided with suitable knives connected by teeth, or other means, so as to insure a simultaneous rotation, and placed on frames connected by hinges or joints. 2d, The attaching of the knives to the cutter heads in reverse positions, so that they will cut from the centres of the staves outwards.

22. Method of Making a Hard Compound of Rubber; George Dieffenbach, City of New York.

Claim—The application of artificial heat to a composition of matter, consisting of sulphate of alumina, and other ingredients, for the purpose of curing and hardening the said composition.

23. Hanging Carriage Bodies; William Doulin, Youngstown, Ohio.

Claim—In combination with any of the ordinary springs of a carriage, an elliptic spring on the reach of the wagon, said elliptic spring being constructed and arranged in the manner set forth.

24. Locks; C. Duckworth, Hartford, Connecticut.

Claim—The tumbler and slotted arm attached to the bolt, lever, or its equivalent, and the key provided with lever, combined and arranged as set forth.

25. Harvesters; J. A. Dufield, McHenry, Illinois.

Claim—Wheels, a a, provided with pins, and diamond-shaped, in combination with cutter bar, shaft, wheel, D, and lever, arranged in relation to each other as described.

26. Fly-trap; Aaron Eames, Kalamazoo, Michigan.

Claim—The combination of the fly receptacle, register, rotating clearer, bait-board, and gate, arranged as set forth.

27. Platform Scales for Railroads, &c.; Thaddeus Fairbanks, St. Johnsbury, Vermont.

Claim—The arrangement of the supporting standards and the loops or supports of the longitudinal levers and platform, with respect to each other, and so as to extend within or into the space between the side timbers of the platform, as specified.

28. Sewing Machines; Wm. A. Fosket and Elliott Savage, Meriden, Connecticut.

Claim—1st, The presser-foot, in combination with the spring and with the needle stock, so arranged that by the operation of the latter, the force of the spring will be taken from the presser-foot at the time the feed of the cloth is to be given, that is, when the needle is out of the cloth, but without raising the said presser-foot from the cloth, in the manner described. 2d, The needle-guard, constructed and operating as set forth, in combination with the needle and with the thread-carrier or looper. 3d, So combining and arranging the double-jointed stock of the thread-carrier with the two levers, as that the said parts shall vibrate in the same plane, and also that the said stock shall form a link between the two levers, which are operated to have their arcs of vibration opposed to each other, whereby, with the least throw of the said levers, the greatest vibration of the thread-carrier is produced.

29. Mills for Crushing and Pulverizing Quartz, &c.; James P. Gage, City of New York.

Claim—1st, The combination of cast-rolls upon wrought iron shafts (the rolls cast solid upon the shafts,) with the wrought iron box or frame, the conicals upon the shaft, and the sliding cast iron journal-boxes, arranged in the manner described. 2d, The combination of the rollers, the case or frame, the box, and the wide shoe, and the diagonal plates, operating in the manner described.

30. Bran Dusters; William Hall, St. Louis, Missouri.

Claim—The combination of the flanch with its arms, and the head with the scuppers, with the brushes and fans, as described.

31. CONVERTING RECIPROCATING INTO ROTARY MOTION; C. A. Harper, Fort Worth, Texas.

Claim—Producing the rotary motion of the shaft and saw by the reciprocating racks, in combination with the gear-wheel, spring pawls, drum, shafts, and wheels, as described.

32. PROJECTILES FOR FIRE ARMS; John Holroyd, Washington City, D. C.

Claim—Constructing the projectile with the reversed curved grooves, A and B, on the rear and front, as set forth.

33. SEWING MACHINES; Henry Hudson, Three Springs, Pennsylvania.

Claim—The carrying of a self-feeding automatic stitch-forming device (like that described, or its equivalent), over the surface of the stretched or stationary fabric, as set forth.

34. HYDRANTS; William Iams, Baltimore, Maryland.

Claim—The movable cylinder and tube, when combined with the fixed piston upon the supply pipe, and so constructed and arranged in relation to the supply pipe, that its elevation shall open a direct communication with the main, in the manner specified.

35. MACHINES FOR PREVENTING ENGINES AND RAILROAD CARS FROM BEING THROWN FROM THE TRACK; A. Livingston Johnson, Baltimore, Maryland.

Claim—In combination with a locomotive and a pioneer safety car in advance of it, the bars fastened to one and extending into loops or mortises in the other, to prevent the lighter car from leaving the track, or one from mounting or riding on the other, in case of accident or sudden stoppage. Also, in combination with the locomotive and pioneer safety car, an advance of the link or drag-bar, so connected thereto, as that the propelling force transmitted through it shall tend to hold the forward part of the safety car to the track.

36. LIFE-BOAT; George W. La Baw, Jersey City, New Jersey.

Claim—The arrangement of ribs with the main rib and keel, and cutwaters, constructed as specified.

37. SAWING MACHINES; Sylvester Littlefield, Alfred, Maine.

Claim—1st, Combining with a circular saw on a vibrating adjustable arm, an auxiliary saw, as described. 2d, Arranging an arm with two guides, in such a manner that it vibrates on the arbor of the saw, and that it can be raised and lowered instantaneously, as described.

38. MACHINE FOR UNLOADING VESSELS; I. I. Magee, Fernandina, Florida.

Claim—The arrangement of the frames, A and H, with rollers and with screws, or their equivalent, as specified.

39. APPARATUS FOR PRINTING ADDRESSES ON NEWSPAPERS, &c.; C. K. Marshall, Vicksburg, Mississippi.

Claim—1st, A chain of plates or solid links, having characters of the description described, placed, cut, or set into the face of its links, and arranged to wind in scrolls upon one pulley or roller from another, as set forth. 2d, The combination of the above with an inking device that supplies the characters made on the faces of the links with ink, and with a stamping device, which will cause the respective links of the chain, as they come into play, to produce a clear impression upon the article being directed or superscribed. 3d, The employment of an inclined hopper having openings in its bottom and furnished with a spring stop, in combination with the revolving bulk-feeding arms. 4th, The combination with the features embraced in the third claim, of the raking single-feeding device. 5th, The use of the scroll-winding post-office indicating belt, with the superscribing chain, or other superscribing device. 6th, The manner, substantially as described, of effecting a combination between said belt and chain. 7th, The combination of the features embraced in the fifth claim, with the "mail" assorting box. 8th, The use of the State-indicating belt with the post-office indicating belt, and with a superscribing device. 9th, The organization of an apparatus, by means substantially as described, for accomplishing, by one continuous operation, the several results specified.

40. PROCESS OF PREPARING PAPER PULP; John Meyerhofer, City of New York.

Claim—In making paper impervious to water, mixing the alkaline solution of rosin with the pulp, and then adding what is known as English sulphuric acid, and after the sheets have been formed, drying them by contact with heated metallic surfaces.

41. SKELETON HOOP SKIRTS; Cæsar Neumann, City of New York.

Claim—Combining a series of spring hoops by means of a series of twisted cords, and thus forming a skeleton skirt.

42. METHOD OF MOUNTING AMBROTYPES; John S. McClure, Mobile, Alabama.

Claim—The employment of a concave back ground or surface, in combination with an ambrotype picture, as described.

43. TACKLE BLOCK; J. E. Palmer, St. Louis, Missouri.

Claim—The form of the block in the inside and the form of the pulley, when the two are combined and arranged as described.

44. BEE-HIVES; John W. Palmer, Port Republic, Virginia.

Claim—Providing the described bee-hives with one or more partitions, with openings, and with feed boxes, which contain separating boxes, constructed as described.

45. EMBOSSING AND FINISHING WOVEN FABRICS; Walter Ralston, Manchester, England; patented in England, November 23, 1858.

Claim—The employment of grooved, fluted, engraved, milled, or otherwise indented rollers of metal, wood, or other suitable material, driven at a greater speed than the bowl or bowls connected with them, so as to exert a rubbing or friction upon the fabric submitted to their action, and thereby produce an indefinite variety of pattern, as well as a bright finish or lustre, and also reversing the operation by giving the bowl a quicker motion than the pattern roller.

46. MACHINES FOR POLISHING RICE; Charles E. Rowan, City of New York.

Claim—1st, The combination of the conductors, constructed as described, and secured within a loose wire cloth cylinder, with the scouring discs, constructed as shown, and secured to the driving shaft, so that the friction of the grain will cause the cylinder to revolve, and lift and deliver the grain through the machine. 2d, In combination with the parts described, I claim the tubes and openings, arranged so that the dust may escape and air may enter to cool the contents of the cylinder during the scouring operation. 3d, Placing the feeding screw upon the same shaft that carries the scouring discs.

47. REEFING FORE-AND-AFT SAILS; Wm. R. Satterly, Setauket, New York.

Claim—The combination with and above the triangular sail, G, of another triangular sail, E, which has

a boom attached to it, so that when the two sails and boom are put together they form the ordinary fore-and-aft sail, operating in the usual manner; but when the sail, H, and its attached boom are removed, the small triangular sail, G, remains.

[This invention consists in dividing a fore-and-aft sail in a line running diagonally from its upper and inner corner to its lower and outer corner, thus making two triangular portions, and so applying these two portions of the sail, in combination with a boom and a detachable gaff, that when, in hard weather, it is desirable to reduce sail, the gaff and outer portion can be expeditiously disconnected from the inner portion and from the boom, and that the upper corner of the inner portion can be connected with the throat halyard, and hauled up to its place without the boom, thus effecting the reduction of sail more quickly than can be done by the ordinary mode of reefing, and obviating the chafing of the reef on the boom, by making the inner portion of the sail constitute a trysail.]

48. STEERING APPARATUS; Nathaniel Snow, Jr., Boston, Massachusetts.

Claim—The steering apparatus, consisting essentially of the wheel, pinion, rods, and yoke, arranged as described.

49. BIT-STOCK; N. Spofford, Haverhill, Massachusetts.

Claim—Arranging the socket of a brace with a slot, in combination with a thumb-screw and projections, or their equivalents, as specified.

[This invention consists in arranging the socket with a slot that divides said socket into two parts, which are forced together by means of a thumb-screw, so that they adapt themselves to different sizes and different bevels of the shanks of bits, and the lower end of the socket is furnished with a projection that serves to retain the bits with quite a moderate pressure of the thumb-screws.]

50. CHURN; E. N. Sprinkle, Marion, Virginia.

Claim—As an improvement on the churn patented to Hatfield & Goldsmith, on July 13, 1858, the combination of the perforated obliquely arranged dashers with the single inclined stationary guard, as set forth.

51. CONSTRUCTION OF BURNERS FOR VAPOR LAMPS; Robert Steel, Philadelphia, Pennsylvania.

Claim—The combination of a metallic gas-generating chamber and burner, applicable to a lamp, chandelier, or other gas fixture, for the purpose of generating vapor or gas from burning fluid, and consuming the same as fast as it is generated, thereby producing a superior artificial gas light, as described.

52. STOVES; John G. Treadwell, Albany, New York.

Claim—Providing the door with an inclined projection on one side and a hinged rack bar on the other, when said door is used in connexion with the cross bar and with the damper, as constructed, the whole being arranged as described.

53. MOLE PLOUGHS; George Whitcomb, Springfield, Ohio.

Claim—The construction of a flexible mould by the combination of sections which are not attached to each other, but by being held in place by the chain, or its equivalent, as set forth.

54. PEGGING MACHINES; Luke H. Ward, Marlboro', Massachusetts.

Claim—The particular arrangement and combination of the feeding apparatus, consisting of the levers, R Q and O, spring, and wheels, in connexion with the lever, U, and its stud, and the awl and driver operated by the levers, W and X, in connexion with the peg-feeding apparatus and pointed saw for cutting off the pegs.

55. AUGER; Simeon Wood, Worcester, Massachusetts.

Claim—The combination of the chipping bit or bits with a band or hook, having teeth or cutters on its bottom edge.

56. PLATFORM SCALES; R. F. Wolcott, Claremont, New Hampshire.

Claim—1st, The combination of the two graduated wheels, screw, and bar, arranged as set forth. 2d, Attaching the lever, I, to the platform, levers, H H, and rod, arranged as described. 3d, The construction and arrangement of the fulcrum arms of the shaft, projections, and plates of the hangers, and the plates of the beams, as set forth.

57. APPARATUS FOR COOLING LIQUIDS; Jean Louis Baudelot, Havencourt, France, Assignor to Henry Migeon, Wolcottsville, Connecticut; patented in France, April 13, 1856.

Claim—A cooling apparatus for liquids, composed of a vertical range of pipes passing the liquids successively from the lower to the upper pipes in said range, in combination with the perforated trough, or its equivalent, supplying the other liquid which trickles over the surface of said range of pipes, as set forth. Also, in such a cooling apparatus, a series of teeth or projections on the under side of the horizontal pipes, for the purpose of conducting or distributing the liquid falling successively from one pipe to the other.

58. SKATE STRAPS; Edward Behr and L. Frœlich, Assignor to Edward Behr, City of New York.

Claim—The rod fitted longitudinally in the stock, provided with screw sections, with cylinders fitted thereon, and one end of the heel and toe straps attached to said cylinders, the latter being provided with the ratchets, d k, into which the pawls, e l, catch, as set forth.

59. TEA AND COFFEE POTS; Thomas Bishop, Assignor to self and James M. Bishop, Plainville, Connecticut.

Claim—The arrangement of the area, flanches upon the lid, with the apertures, in the manner described.

60. SHANK-LASTER; D. G. Chase, Boston, Massachusetts, Assignor to George Parr, Buffalo, New York.

Claim—The jointed cross-bars provided with the swivel jaws and swivel nuts, in connexion with the right and left screw shaft, arranged as set forth.

61. METHOD OF ADJUSTING CIRCULAR SAWS; John Colville, Assignor to self and T. L. Colville, Wilmington, North Carolina.

Claim—The expansion ring or plate of copper, or any other suitable metal capable of being expanded, for setting or adjusting the saw properly upon the shaft at any given point or points, when the same is interposed between the saw and fixed collar.

62. FLY-TRAP; Wm. Elwell, Assignor to self and N. O. Mitchell, Gardiner, Maine.

Claim—The two boxes, of a quadrangular or other shape, provided with sliding glass tops and sliding bottom, in combination with the perforations surrounded with projecting pins, for the purposes, arranged in the manner set forth.

63. CAST METAL PULLEYS; John A. Evarts, Assignor to Homer Curtis, West Meriden, Connecticut.

Claim—Forming the core of the sheel by covering the wheel with the sand, and having the hole made

through the core, so that, in casting the sheel, the pintle or axis of the wheel will be cast simultaneously with the sheel, and the wheel, when the sand is removed, be properly adjusted with the sheel, as described.

64. ROTARY PUMPS; John Jewell Flanders, Assignor to self and E. G. W. Bartlett, Manchester, N. H.

Claim—The combination of the revolving, annular, inverted gear, the pinion, and stationary crescent, arranged to operate in the case, as described.

65. APPARATUS FOR MANUFACTURE OF COAL OIL; H. K. Symmes, Assignor to self and R. W. Holman, Newton, Massachusetts.

Claim—1st, An oil retort, A, in combination with the gas retort, D, or its equivalent, for the purpose of saving the gas which escapes from the oil retort, and to improve its quality. 2d, In combination with the two retorts, A and D, I claim the pump, or its equivalent, for the purpose of imparting to the gas the necessary pressure.

66. POCKET ALARM; Isaac Goodspeed, Norwich, Connecticut, Assignor to self and George A. Mansfield, Boston, Massachusetts.

Claim—The pocket, thief, and burglar alarm, constructed in the form and manner described. Also, the combination and arrangement of the independent lever, adapted to cap and cock the alarm, and while both the cap-tube and hammer are arranged within, and do not project outside the shell or case.

67. STEAM BOILERS; Stephen H. Head, Assignor to self and Wm. P. Parrot, Boston, Massachusetts.

Claim—In combination with the furnaces and the lateral passage and damper, chamber, F, located at the front of the furnaces, and between them and flues, for the purpose and in the manner set forth.

68. TELEGRAPHING MACHINES; George M. Phelps, Troy, New York, Assignor to the American Telegraph Co.

Claim—Producing from a magneto-electric battery, the momentary electric currents required for actuating the printing mechanism, by giving momentary motion to the armature or other current-inducing part of the magneto-electric battery, by means of a set of finger-keys, which, when depressed, are controlled in their action upon the current-inducing part of the magneto-electric battery, by a mechanical contrivance which constantly moves in harmony with the unintermittingly-revolving type-wheel. Also, increasing the capability of the instruments for telegraphing, by so increasing the speed of the transmitting device and type-wheel in relation to the motion of the parts which perform the printing, that two or more types shall pass the platen while the printing mechanism is acting once. Also, turning the cylindrical platen while each impression is being made, by means of rings of teeth upon the type-wheel and platen. And, finally, making a revolving wheel or shaft turn the corrector, armature, or another wheel or shaft, a certain fixed distance, with the same speed as itself, at any time and any desired number of times, by the use of a ratchet wheel, catch, guide, and detent, arranged together, and, with the said driving and driven wheel or shaft, for conjoint operation, as set forth.

69. CLOTHES DRYER; Charles A. Gale, Boston, Assignor to Albert S. Hall, Malden, and A. R. Davis, Cambridge, Massachusetts.

Claim—The combination, substantially as described, of the mantel, shelf, and the folding slats, arranged as set forth.

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70. CLOTHES IRONING APPARATUS; Corintha Alden, Cassadaga, New York.

Claim—The arrangement of the box with the follower, or its equivalent, in combination with the tank, as specified.

71. CORN PLANTERS; Ephraim C. Allen, Le Roy, New York.

Claim—The arrangement of the various parts of the seeding machine described.

72. REFINING SUGAR; John Aspinall, London, England; patented in England, February 8, 1859.

Claim—The method described of effecting the blowing-up or melting of raw sugars; that is to say, by so supporting or upholding the sugar that successive portions will be brought into contact with the water, whereby the sugar will be melted at or near the surface.

73. COMPENSATING PENDULUM; Merrick Bemis, Ashburnham, Massachusetts.

Claim—Arranging a part of the rod in the form of a bow or sectoral bend, and applying to such bend or part a clasp or bow of metal having a different expansive ratio.

74. DEVICE FOR APPLYING STEAM AS A MOTOR; Robert Blair, Malugin Grove, Illinois.

Claim—The combination with a radial lever or frame, and circular railway, and central revolving, power-transmitting shaft of a traction steam engine, when the crank axes of said engine radiate from the central shaft, and the inner traction wheels are made of smaller diameter than the outer one.

75. CORN SHELLERS; Nelson Burr, Batavia, Illinois.

Claim—The peculiar arrangement of the section, provided with the ring and placed relatively with the cylinder and adjoining sections.

76. SHOEMAKING TABLE; Thomas Carpenter, Battle Creek, Michigan.

Claim—The movable bottom, arranged in combination with the bench and compartment box, constructed as described.

77. STEAM VALVES; R. Carkhuff and B. Chalfant, Lewisburgh, Pennsylvania.

Claim—The peculiar arrangement of the slide and traverse bar, t, which form the valve of the steam chest, the bar, U, and the cross-arm of rod, whereby said valve is allowed a lateral as well as a longitudinal movement within the chest.

78. GIRTH BUCKLES; L. C. Chase, Boston, Massachusetts.

Claim—Constructing a buckle with wings, or their equivalents, and furnished with holes.

79. WATER-METRES; B. S. Church, Manhattanville, New York.

Claim—1st, The arrangement of the partitions in the trough, as described, in combination with the air-tight chamber, D, chamber, F, and tubes, whereby that portion of the water which does not pass through the measuring buckets is prevented carrying off any of the air in the chamber, D. 2d, Arranging in the air chamber, D, a float, in combination with a valve, or its equivalent.

80. PACKING FOR SLIDING GAS-LIGHTS; George Clay, City of New York.

Claim—The combination with the pipe, D, shell, and pipe, B, of the elastic tube, when the latter is fitted

so that its central portion will contract and press upon the burner or upon the sliding pipe, so as to form a gas-tight joint.

81. PROJECTILES FOR RIFLED ORDNANCE; J. W. Cochran, City of New York.

Claim—1st, The band of copper, or other wire, applied in combination with the cup or cup-like frame attached to the rear of the projectile. 2d, The expanding ring, applied in combination with a conical surface, formed behind a shoulder on the front part of the projectile.

82. PROJECTILES FOR RIFLED ORDNANCE; J. W. Cochran, City of New York.

Claim—The application to a projectile for rifled ordnance of a covering, or of one or more bands, composed of a coil or coils of copper, or other wire, wound upon its exterior.

83. RAILROAD GATE; D. W. Comstock, Chicago, Illinois.

Claim—Placing the ends of two pairs of adjoining rails on a rising and falling platform, when the latter is suspended from the short arms of crank levers, the long arms of which carry the panels of a gate.

84. RAILROAD CAR SPRINGS; Wm. F. Converse, Harrison, Ohio.

Claim—1st, The combination of a clamp with a disc spring, in the manner explained. 2d, In connexion with the above, I claim the series of annular steel discs of unequal diameter.

85. CHURN-DASHER; N. B. Cooper, Gratis, Ohio.

Claim—The arrangement of the arms on the two points, one on each side of the upright, when the upright is made removable by means of the ways.

86. STEAM BOILER; Edward Crane, Dorchester, Massachusetts.

Claim—A fire-box surrounded by a water-jacket, the combination of the tubes in the fire-box with the boxes or chambers, so that a number of tubes shall have the same connexions through the said boxes or chambers with the water-jacket and steam chamber, and shall also be capable of being put in and taken out of the boiler at the same time. Also, the use of tubes coiled or folded into the fire-box, and connected with the water-jacket and steam chamber through the boxes or chambers, as described, of such length in proportion to their diameter that all the water entering them at the lower end shall be converted into steam in the lower portion, and the steam be superheated in the upper portion before it is discharged into the steam chamber. Also, the use of tubes in the steam chamber for discharging the steam generated in the tubes in the fire-box, so bent that the superheated steam issuing therefrom shall be discharged into a drum, around the chimney and against the chimney, in the first instance, and then against the surface of the water. Also, the use of the drum around the chimney in the steam chamber for securing the discharge from the tubes, and checking the disturbance of the water through the whole extent of the steam chamber. Also, the combination of the blow-off cocks with the stop-cocks, for the purpose of blowing off each section of tubes separately. Also, the use of the tube coiled around the chimney, for the purpose of taking the steam from the steam chamber, at the point where it has the highest temperature.

87. RAILROAD CAR WHEELS; Edward Crane, Dorchester, Massachusetts.

Claim—A wheel having its rim and tire secured together by india rubber vulcanized in place.

88. CLOTHES DRYER; Munson C. Cronk, Auburn, New York.

Claim—The combination and arrangement of the hollow post, the sliding piece, brace cords, the hub, the stands, the radial arms, and the ring, in the manner specified.

89. PANS FOR EVAPORATING CANE JUICE; C. A. Desobry, Plaquemine, Louisiana.

Claim—The heaters, of inverted cup form, applied within the pan, in combination with the system of connexions and the two series of pipes below the pan, as described. And in combination with the said heaters, connexions, and two systems of pipes, I claim the pipes passing through the said heaters, as described.

90. PUMPS; Jacob Edson, Boston, Massachusetts.

Claim—1st, The peculiar manner in which I support the cylinder upon the flanches, in combination with the vacuum chamber, for the purpose of insuring an unobstructed passage between the said chamber and the induction pipe below the valves. 2d, The manner described of securing the induction pipe to the pump by means of the projecting bearing points, operating as set forth. 3d, The described combination and arrangement of the division plate and the cylinder, whereby the body of the pump is divided into two distinct chambers, the one serving as an air or water chamber, and the other as a vacuum chamber.

91. LETTER SCALES; Thaddeus Fairbanks, St. Johnsbury, Vermont.

Claim—Not only with its pendulous weight, E, connected with the scale pan by a forked arm, provided with bearings for receiving and resting on knife edges of a bar, extended from the steelyard, as specified, but with a bar steelyard made without any fork, and extended into a stationary staple or stop, arranged in the manner specified.

92. SASH-FASTENER; John M. Forrest, Norfolk, Virginia.

Claim—The springs and the ratchets, as constructed, in combination with the levers and cord, operating as described.

93. MANUFACTURE OF GAS; Leonard D Gale, Washington City, D. C.

Claim—The treatment of bitumen, bituminous coal, and their distillates, or their equivalents, by first converting the volatile portions to a state of vapor, at a temperature below a cherry red heat, and then forcing the vapor so generated into contact with a red-hot surface, in such a manner that the gas generated may be instantaneously removed from the said heated surface, and thus be prevented from further decomposition.

94. MACHINES FOR HOISTING MARL, &c.; Thaddeus A. Granger, Wilson Co., North Carolina.

Claim—The construction of the cap timber, in combination with the supporting timber which forms the swivel, to allow the beam to be moved to any point desired.

95. MANUFACTURE OF GAS; Leonard D. Gale, Washington City, D. C.

Claim—The treatment of all woody, resinous, and fatty bodies, as well as all tarry matter, except bitumen, bituminous coal, and other distillates, by first converting the volatile portions to vapor at a temperature below a cherry red heat, and afterward forcing the vapor so generated into contact with a red-hot surface in such a manner that the gas generated thereby may be instantly removed from said heated surface, and thus be prevented from further decomposition.

96. APPLYING PRESSURE TO TOP ROLLS OF DRAWING MACHINERY; Noah E. Hale, Nashua, New Hampshire.

Claim—The arrangement and combination of the drawing rolls, straps, attached at the ends of said rolls, adjustable bars, lever, weight, rod, bell crank lever, and hanger, as described.

97. Carriage Seats; E. H. Harris, Palmetto, Georgia.

Claim—Attaching the seat to the body of the vehicle by means of the bars and rods, so as to permit of a certain degree of play of the seats or movement thereof, independent of the body.

98. Ploughs; J. P. Harris, Byhalia, Mississippi.

Claim—The combination of the separately adjustable and removable mould-board with a subsoil share situated behind and below it—the said subsoil share being also separately removable, to allow the separate use of said mould-board.

99. Machines for Pulling and Cutting Cotton and Corn-stalks; Horatio F. Hicks, Grand View, Indiana.

Claim—The combination of the reel, paddle, drum, and cutter, operating as set forth.

100. Sewing Machines; Wm. Cleveland Hicks, Boston, Massachusetts.

Claim—As my method of controlling needle thread in sewing machines, by a combination of mechanism, as described, by which a bar or wire, through which the thread passes, and by which the thread is tightened and loosened, shall have the described motion combined, firstly, to be drawn up by the needle bar, or its equivalent, during its entire upward motion; secondly, held at rest until the needle-eye is at or near the material to be sewed; and thirdly, to be disengaged and allowed or caused to fall by its own gravity, or by the assistance of a spring, for the purpose of gaining the amount of motion lost by remaining at rest during the first part of the downward motion of the needle bar.

101. Horse-shoe; N. E. Hinds, Cooperstown, New York.

Claim—1st, The wider and thicker enlargement of the toe or fore part of the shoe. 2d, The trough-like concave form of the underside of the shoe and the raised edges that ensue, as a consequence of the construction of said concave form. 3d, The construction of calks made in a V or double V-form.

102. Cider Mills; A. D. Hoffman, Belleville, Michigan.

Claim—The combination of the crushing rollers, pressure rollers, and endless apron, when the crushing rollers are provided respectively with teeth and recesses, and the pressure roller provided with the yielding bars and canvass covering.

103. Pulley Blocks; S. F. Lewis, San Francisco, California.

Claim—1st, The arrangement and combination of the pulleys, shoe, and eccentric within the block. 2d, The teeth or projections and stop, formed respectively on the pulley and shoe, to operate as set forth.

104. Abdominal Corsets; James P. McLean, City of New York.

Claim—A corset or belt with cork brackets or projections on its zone, the upper or top edge of such brackets being beveled, in combination with the abdominal pads which form a part of the lower section of the corset or bandage, and are held in their places by the same.

105. Knife-cleaner; James McNamee, Easton, Pennsylvania.

Claim—The upper socket, with its pad operated by the socket, F, with its pad, and the reservoir, the pad of the lower socket is rendered adjustable in respect to the reservoir.

106. Seeding Machines; Allen N. Merrill, Batavia, Illinois.

Claim—1st, The employment or use of a longitudinal adjustable shaft, provided with cylinders, having different sized seed cells, in connexion with perforated bars, slides, and plate, arranged as set forth. 2d, The arrangement and combination of the spout, conductors, shoe spouts, and elevating arms on shaft, connected to the conductors.

107. Portable Gas Apparatus; John H. Miller and Samuel Albright, Grafton, Virginia.

Claim—A portable gasometer furnished with a central gas discharge pipe, a central guide rod, a flexible connecting pipe, and one or more ratchet bars, and arranged in a frame which is provided with one or more spring pawls, for use in a railroad car, or other traveling apparatus, which is subject to a jolting or vibrating motion, for the purpose of supplying gas to a series of gas burners.

108. Skirts; Charles Minzheimer, City of New York.

Claim—The expanding joint and strings, or their equivalents, at the back of the skirt, in combination with the openings in the other.

109. Corn Planters; Oliver P. Moran, Haynesville, Missouri.

Claim—The combination of the curved concentric aperture in the bottom of the seed-box with the sliding strike and measuring holes, for the purpose of charging said holes from the seed-box with the least possible weight upon, and impediment to, the motion of the dropping wheel. Also, the combination of the concentric vibratory arm and projecting pin thereon, with the measuring holes, for the purpose of imparting the proper movement to the dropping wheel. Also, the arrangement of the instant valve upon the curved weighted hinge, which is pivoted to the sides of the chamber in a position nearly vertically over the valve, in combination with the slotted connecting rod, for the purpose of producing a superior thickness and delicacy of action on the valve.

110. Casting Car Wheels; Austin W. Moses and Joseph A. Springer, Philadelphia, Pennsylvania.

Claim—The described method of casting railroad car wheels, by pouring the central portion of the wheel, independently and in advance of the tread, to allow said central portion to cool and contract to any desired degree before adding the metal forming the tread of the wheel; said end is accomplished by the employment of a ring, composed of any convenient number of segments, or their equivalents, and arranged to operate in combination with the annular part of the flask.

111. Straw-cutters; Jacob H. Mumma, Harrisburgh, Pennsylvania.

Claim—1st, The employment of a hawk-bill cutter, constructed and arranged in connexion with a cutter bar of a straw-cutter, operating as set forth. 2d, The slat bed, for the purposes of not only cleaning the material from dirt, but also as a feed to the rollers. 3d, The employment of the rib. feed rollers for crushing and dividing the sheet of material to be cut, arranged and combined with a hawk-bill cutter and bar.

112. Sawing Machines; Adrian V. B. Orr, Lancaster, Pennsylvania.

Claim—The oscillating lever, in combination with the spring and feed lever, and operating either a single saw or a pair of saws.

113. Heating Apparatus; George R. Osbrey, Providence, Rhode Island.

Claim—The combination of the alcohol reservoir and vaporizer with a lamp for heating the same, when such vessels are connected by a liquid pipe and a vapor pipe, said pipes acting in such connexion to maintain

a constant level within the vaporizer. Also, combining with such device for vaporizing, a conical disseminator and a convex deflector.

114. MACHINE FOR CUTTING BOOT AND SHOE SOLES; George W. Parrott and Charles K. Bradford, Lynn, Mass.

Claim—The combination and arrangement of an automatic feed, sole by sole, with the cutting knives.

115. CLARIFYING AND REFINING SUGAR JUICES, &c.; Hiram G. C. Paulson, Flatland, New York.

Claim—The application of alcohol, in combination with water, in all the proportions as stated, and at the temperature of boiling of said combined liquids to the melting or dissolving, boiling or treating raw sugars or juices of saccharine substances.

116. COOKING RANGE; William Pellet, City of New York.

Claim—The combination with a central fire-grate having openings in its side, and with the side roasting chambers or spits, of dampers, which can be adjusted so that the roasting may either be effected in the side chambers, by direct action of the burning coals, or by the heat radiated from the sides of the fire chambers.

117. SWEAT-KNIFE FOR CUTTING HAT AND CAP LININGS; Edward R. Pye, City of New York.

Claim—The employment or use of the knife on the projection of the bar, and secured thereto by the set-screw, in connexion with the pointed wheel attached to the projection.

118. PORTABLE TURN-TABLE; John Robinson, of Eli, Sharptown, Maryland.

Claim—The adjustable sliding turn-table, constructed as specified.

119. STOVES, RANGES, &c.; Josiah M. Reed, Boston, Massachusetts.

Claim—The application and construction of the flue with its door, as described.

120. INSECT POWDER-BLOWER; Peter Reynard, City of New York, and Victor Varin, Brooklyn, New York.

Claim—1st, The ball, attached directly to the chamber or neck, and acting to blow the powder out of the neck or chamber, either with or without the valves, as specified. 2d, The holder, composed of the rod, e, and ring, provided with the rod, g, and the button, to act on the elastic ball, as described.

121. STUMP EXTRACTORS; C. Bird Pate, Moore's Mill, Indiana.

Claim—The arrangement of levers and spar, as set forth.

122. SEWING MACHINES; Israel M. Rose, City of New York.

Claim—The combination of two needles and a shuttle, to operate as set forth, for the purpose of producing a stitch of the structure described.

123. STOVES; Christian Charles Schieferdecker, Baltimore, Maryland.

Claim—The combination of the central air space, containing material refractory to heat, with the series of surrounding ascending and descending smoke flues, arranged as described.

124. SEWING MACHINES; Charles Scofield, Adams, New York.

Claim—1st, The auxiliary feeding plate, Q, with pins or teeth on its surface, in combination with the perforated, slotted, main feeding plate, N, when said plate, Q, combines in itself the properties of a spring, and of a feed bar, and is otherwise arranged in the manner described. 2d, The arrangement of the pivoted lever, adjustable collar, pressure pad, and needle lever, in the relation shown to one another, and for united operation in the manner set forth. 3d, The lever, made elastic, laterally pivoted at n, provided with a pin, and coupled to the pressure pad by an adjustable collar, in combination with the needle lever and the recess in the standard. 4th, The looper, W X U T, when the part U T is made rigid and attached to the horizontal rock shaft, and the part W X is made yielding or with a spring, and formed or arranged on one side of part U T, and in the relation shown to a projection on the peripherical surface of the actuating cam. 5th, The combination of the adjustable intermediate plate with the jaws of the looper, for the purpose of adapting the same looper without removing it from the machine, which is used for sewing either in the double-looped or other stitch made with two threads, for sewing in the chain-stitch.

125. MACHINE FOR MAKING BOX JOINTS; James Stimpson, Baldwinsville, Massachusetts.

Claim—1st, The combination of the hollow bit, the cutters, or their equivalents, operating to form the tenons. 2d, In combination with the above, I claim the auger bit, operating to form the holes to correspond with the tenons.

126. CARVING-KNIFE; Chester W. Sykes, City of New York.

Claim—The combination of a knife and shears, as described.

127. STRAW-CUTTERS; Harvey Trumbull, Central College, Ohio.

Claim—The combination of a self-adjusting spring pressure clasp, to or with an automatic rake, for the purpose of feeding the material to the knife.

128. GATES; Nathaniel Waterbury, Fond du Lac, Wisconsin.

Claim—The arrangement and combination of the pendulous rod and weight with the axis of the pulley.

129. HOT-AIR FURNACES; James Whitehill, Frederick, Maryland.

Claim—1st, A furnace, constructed with two separate fire chambers and grates, with an air passage between the chambers, closed at their sides, but open at the bottom and top. 2d, The combination of the peculiar labyrinthian air passage and the peculiar furnace described. 3d, The combination, with the peculiar furnace and peculiar labyrinthian air passage described, of the curved cold air pipe.

130. COTTON GINS; Ferdinand Wuterich and Jacob Koerber, City of New York.

Claim—The arrangement of the finger shafts, C and D, operating in the manner described, and acting together so that, while the fingers of the shaft, C, during its revolution, pull the cotton out of the hopper, the fingers of the shaft, D, take the cotton from the former, and deposit the same upon the guiding rollers.

131. MODE OF CONFINING THE SEAT OF THE DRIVER ON CITY RAILROAD CARS; Wm. C. Allison, Assignor to self and John Murphy, Philadelphia, Pennsylvania.

Claim—The combination of the board, rod, with its collar, and the catch, when the said rod serves the double purpose of supporting the seat, and, in conjunction with the catch, of maintaining the seat folded up out of the way.

132. HANDLES FOR SMOOTHING IRONS; Henry C. Brown, Buffalo, New York, Assignor to Charles O. Brown, Dalton, Massachusetts.

Claim—A ventilating smoothing iron handle, constructed as described.

133. RAILROAD CAR SPRINGS; Wm. E. Cooper, Dunkirk, New York, Assignor to Charles D. Gibson, City of New York.

Claim—The combination and arrangement of groups of four springs by and with the suspension bracket or stirrup, arranged in the manner described.

134. SLEEPING CARS; John Danner, Assignor to self and J. M. Jay, Canton, Ohio.

Claim—The combination of the hinged back, d', with the hinged and reversible frame, and removable piece, arranged to operate in relation to seat and false back of the back, B'.

135. APPARATUS FOR HEATING HYDRO-CARBON LIQUIDS; Pearson B. Kitchen, Assignor to Wm. H. Marshall, Philadelphia, Pennsylvania.

Claim—The application to gas generators of a hot air chamber, and the submerging of one or more air pipes therefrom, into and upon the chemicals, for the purposes set forth and described.

136. LAMPS; A. H. Knapp, Assignor to self, E. H. Barstow, and A. R. Trowbridge, Newton Centre, Mass.

Claim—The wick portion, arranged as described.

137. COMPOSITION FOR DETERGENT PURPOSES; Ambrose Lovis, Assignor to self and Charles E. Hodges, Boston, Massachusetts.

Claim—The described cleansing, bleaching, and disinfecting liquid, consisting of an alkaline silicate combined with chlorine.

138. METHOD OF DRIVING PILES; James A. Whipple, Boston, Assignor to self and George A. Stone, Roxbury, Massachusetts.

Claim—The method or process of driving piles by exploding charges of gunpowder, or its equivalent, between the pile and a fulcrum or resistance, so that the force of the explosion shall wholly or partially act to drive the pile in the direction of its length, or nearly so.

139. PORTABLE LOCOMOTIVES; Joseph Barrans, Caledonia Terrace, Queen's Road, Peckham, County of Surrey, England.

Claim—1st, The method described of supporting the front portions of traction or portable steam engines, by means of a spring or elastic beam or lever, at or near the middle thereof; the said beam or lever being arranged constantly to occupy a position in a vertical plane passing through the axis of the boiler, by having its near and front ends applied and jointed respectively to the bottom of the barrel of the boiler, and to the fore-carriage. 2d, The application and use, in traction engines, of tensional rods or bars for retaining the driving wheel centres at the proper distance asunder from the axis of the ground driving wheels. 3d, The application and use, in traction and portable steam engines, of ground driving wheels, in two or more sections capable of being put in and out of working action, for the purpose described, and such wheels having teeth holding projections upon their peripheries of the form and arrangement described.

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140. METHOD OF PRINTING FLOOR CLOTHS; James Albro, Elizabeth, New Jersey.

Claim—The production of grained or variegated designs upon oil cloth, by applying the printing blocks to cushions or pads upon which the colors have been previously "grained" or "combed."

141. BREECH-LOADING FIRE ARMS; Wm. H. Arnold, Washington City, D. C.

Claim—1st, The combination of the cap-lever, shackle piece, pin, and grooves, with the breech piston, for operating as described. 2d, The combination of slide piece, joined as described, with the pin and hammer, operating as set forth. 3d, The cavity in the piston, for the reception of the rear projecting tail-piece of the projectile.

142. RECLINING CHAIR; J. M. Baird, Wheeling, Virginia, and Levi F. Smith, Stonington, Connecticut.

Claim—1st, The combination and arrangement of the oscillating pedestal, vertical lever, the sliding seat frame, and stand, as described. 2d, In combination with the fall, the vibrating foot-board, the oscillating bars, and pitman, or their equivalents, in the manner described.

143. MECHANICAL MOVEMENTS; Wm. H. Baker, Tamaqua, Pennsylvania.

Claim—The drum, placed loosely on the shaft, and having ropes or chains, and a weight or weights attached to it, in connexion with the toothed spring, toothed wheel, train of wheels, fly-wheel, and cam, fitted between the friction rollers of the shaft, as set forth.

144. GAUGE FOR IRON AXLES; Wm. C. Bamberger, Washington City, D. C.

Claim—An axle gauge, constructed in the manner described.

145. SHIP-BUILDING; Jacob W. Banta, Buffalo, New York.

Claim—Extending the planking upon both sides of the bow, and uniting their contiguous ends forward of the dead wood, the planking and dead wood being chamfered to admit of such extension and union.

146. BURR CYLINDERS; James Bidwell, City of New York.

Claim—Securing the toothed plate in place by providing them with projections or recesses, to fit to corresponding recesses or projections provided in or on the interposed packing rings fitting to the body of the cylinder.

147. MOLE PLOUGHS; Aaron Bowers, Jacob H. Griggs, and John Wilson, Monmouth, Illinois.

Claim—The combination of the peculiarly constructed mole with the scrapers and presser, arranged as set forth.

148. TOOL FOR CUTTING CORKS; Adolful Brass, Newark, New Jersey.

Claim—A cutter consisting of two curved blades, two spring or hinged arms, and a sliding ring, with extensions, as set forth.

149. MACHINE FOR PACKING STARCH, &c.; Isaac A. Brownell, Providence, Rhode Island.

Claim—1st, The tunnel, as constructed, for the purpose described. 2d, Attaching the cams to upright strips of wood or metal, which receive and transmit to the said cams the motions which reduce in bulk the commodity placed therein. 3d, The wheel, F, for holding and carrying the blocks, in combination with the cam wheel, G, and the stud, &c., for imparting the motion which reduces the commodity in bulk, and also the intermittently-rotary motion to the wheel, F. 4th, The arrangement of the foot lever, and the rod, V, and

the punch, with the rod and plate. for the purposes specified; also. in combination with the punch, the pawl, rod, y, and sliding hub, for liberating the wheel, r, at the proper time. 5th, The rail and the studs, &c., with the stop for withholding, in the manner specified.

150. Knitting Machines; Joseph Bullock, Cohoes, New York.

Claim—The employment, in combination with such a circular series of stationary needles, of a series of lever-like jacks, applied as described, and having a movement between the needles in a direction radial to the centre of the machine, but no rotary motion.

151. Martingale Ring; George T. Bushnell, Birmingham, Connecticut.

Claim—A martingale ring whose exterior edge is thinner than the interior, in combination with an exterior band, whose edges extend down upon the sides of the ring, forming a hollow or corrugated band on its surface.

152. Fastening Metal Hoops on Cotton Bales; John T. Butler, Natchez, Mississippi.

Claim—The combination of the buckle frame, made without any opening in the border of it, with the hooks, when the latter are received through the former and held in place by the pressure of the bale against them.

153. Nozzles for Fire Engines; Lysander Button and Robert Blake, Waterford, New York.

Claim—The removable ring, constructed and combined with the adjutage, as set forth.

154. Ore-washer; William L Carter, Marietta, Pennsylvania.

Claim—A double conical-shaped vessel, provided with teeth or cutters inside at the end where the ore is received, and the grinders, with the means described for supporting and adjusting the same.

155. Machines for Folding Paper; Cyrus Chambers, Jr., Philadelphia, Pennsylvania.

Claim—1st, So arranging the drop roller that it shall co-operate with one of the feeding rollers in feeding-in the sheet. 2d, Forming grooves in the folding rollers for the reception of the adjustable guides. 3d, The combination of the carrying roller with the folding roller for carrying in the sheet. 4th, Giving the curved bars a projection beyond the surface of the rollers, for the purpose of raising or bearing off the sheet from the folding roller. 5th. Moving the folding knife in an arc around one of the folding rollers. 6th, Placing the centre of the arc in which the folding knife moves, near or within the periphery of the roller around which it moves. 7th, Corrugating the sheet as it passes from one folding mechanism to a position to be acted upon by the next, for the purpose described. 8th, Turning or conducting the paper by means of the bent bars, in the manner specified. 9th. The combination of the bent bars with the straight bars and adjustable stop, arranged in the manner described. 10th, The combination of the bent bars with the tapes and stop, for the purpose specified. 11th, The oscillating packer or plunger, having its centre of motion below the point of contact with the folded sheets. 12th, The yielding catches for preventing the return of the packed sheets, constructed as described. 13th, Making one or more notches in the plunger for cleaning the yielding catches.

156. Harvesters; George E. Chenoweth, Baltimore, Maryland.

Claim—The described arrangement and combination of the finger bar and main frame, whereby the bar can be folded forwards to the side of the machine with its front downwards, so that the platform can remain attached to the bar, and occupy a vertical position therewith when folded to this position.

157. Churn; Philip L. Clow, Cohoes, New York.

Claim—1st, Hanging the outer parts of two contrarily-revolving dashers to the central portions by hinges, in the manner set forth. 2d, The arrangement of the air-pump and water reservoir with the revolving dashers and cream vessel, as described.

158. Rotary Churn; Aaron L. Cornell, City of New York.

Claim—The arrangement of the rotating shafts, armed with the concave or recessed crags or dashers, within the two concave or half-cylinder chambers, placed back to back.

159. Apparatus for Working Ships Boats; H. Davidson, of the United States Navy.

Claim—The boat apparatus, consisting of the reel, the attaching and detaching hooks, constructed as specified.

160. Mowing Machines; Thomas H. Dodge, Washington City, D. C.

Claim—1st, The arrangement and combination of the levers, standards, and cords, with shoe, whereby the driver, from his seat on the machine, can elevate either end of the finger bar independently of the other, or the entire bar. 2d, The combination of the cutting apparatus with the main frame and mechanism, so constructed and arranged that the driver can, without leaving his seat on the machine, fold up and unfold the finger bar without taking hold of it with his hand. 3d. The combination and arrangement of the levers with the driver's seat and cord or chain, whereby the driver may, when necessary, employ both his hands and his feet, together with the power of the team, to raise the finger bar and cutting apparatus. 4th, So combining mechanism with the machine as that the driver can employ the power of the team to assist to elevate the finger bar and cutting apparatus at pleasure, without changing the horizontal position of the main frame. 5th, In a reaping and mowing machine, the folding guard and rein-hitch, in combination with the driver's seat. 6th, The flexible or adjustable draft connexion to which the team is attached, in combination with the coupling arm and shoe. 7th, The spiral cutters, when constructed and arranged as shown in fig. 11, and operating as set forth. 8th, Hinging the track-clearer to the extension piece by means of the cranks, for the purposes described. 9th, So constructing the track-clearer that its weight may be adjusted, in the manner set forth.

161. Cotton Scrapers; Miles Earnhart, Cold Water, Mississippi.

Claim—The arrangement and combination of the double adjustments of the mould-board with the stock and rigid supporting brace, as specified.

162. Telegraphic Machines; Moses G. Farmer, Salem, Massachusetts.

Claim—The use of a key or circuit-breaker, which shall close one circuit before or at the same time that it opens another, in connexion with an electro-magnet with two sets of helices operating on one and the same armature lever, or two separate electro-magnets operating upon one and the same armature lever, for the purpose of transmitting two messages simultaneously upon a single wire.

163. Milk Can; William Frost, Amenia, New York.

Claim—A milk can provided with tinned iron hoops, with their ends connected together by rivets and solder, either or both, and secured on the can by solder.

164. CONSTRUCTION OF SHIPS AND OTHER NAVIGABLE VESSELS; Rollin Germain, Buffalo, New York.

Claim—1st, Vessels for navigation when the bow and stern sections shall taper uniformly, and the vessel below its water-lines be of the form and model described, and when the relative proportions as to length, breadth of beam, and draft of water shall be such, that, if a right line be drawn longitudinally through the middle, commencing at the water-line at the bow and terminating at the water-line at the stern (when the vessel is loaded), and another line be drawn at right angles to said line along the water surface, from the water-line on one side to the water-line on the other side, at the middle of the part of the vessel where a cross-section below the water-line is greatest, and from every point in this last described line right lines be drawn to each end of the first-described line, the average of all the angles made by these last lines with the first-described line shall not exceed two degrees. 2d, The combination of the fin-like projection with a vessel constructed, below its water-lines, as described. 3d, The combination of the overhanging deck with a vessel constructed, below its water-lines, as described. 4th, Constructing the pilot-house and smoke-stacks (separately,) in respect to their forward and rear parts, in a tapering or wedge-like form. 5th, The combination of the notched plates, the iron knee, and rivets, with a vessel constructed as described.

165. CYLINDERS FOR SMOOTHING WALKS, &c; James Giles, Dryden, and C. B. Tompkins, Ulysses, New York.

Claim—Making cylinders for rollers and other purposes, with grooved metal flanches, into which wood staves are fitted, which form the rolling surface. Also, the mode of making and applying cross-bars between rollers, when two or more cylinders are required for smoothing surfaces, as described.

166. APPARATUS FOR STARTING CITY RAILROAD HORSE CARS; George Hamel, Abington, Pennsylvania.

Claim—The relative arrangement of the levers, the pawls, in combination with the rest pins and inclined planes, the draw-bar, in combination with the inclined pieces and the staying pins, for holding and releasing the draw-bar. Also, in combination with the said draw-bar, the devices, H I K L and M, arranged so as to be operated by the cam for their re-adjustment, in the manner described.

167. POTATO HARVESTERS; Jacob E. Hardenbergh, Fultonville, New York.

Claim—1st, The employment or use of an adjustable share, in connexion with the rotary screen, and with or without the discharging device, the parts being applied to a mounted frame, and arranged to operate as set forth. 2d, The rotary discharging device, placed eccentrically on the screen, kept in proper relative position therewith by the plate, and rotated from the screen by the projection. 3d, The combination of the share, rotary screen, and discharging device, when attached to a mounted frame, and arranged so that the screen and the discharging device may be adjusted independently of the share, and the discharging device rotated by the screen, and kept in an eccentric position thereon for the purpose specified.

168. MACHINES FOR GRINDING GLASS; Albert H. Hook, City of New York.

Claim—The combination of the inclined carriage and cylinder, arranged in the manner specified.

169. BEDSTEAD-FASTENING; Elisha G. Hopkins, Penn Yan, New York.

Claim—The construction and arrangement of the parts, C D E and F, as specified.

170. HARVESTERS; M. G. Hubbard, City of New York.

Claim—The universal joint in the reel in which the arms and wings are pivoted, or flexible and yielding. Also, the combination of the flexible reel with the flexible platform, in the manner specified. Also, the outer reel-arm, in combination with the flexible reel and platform, as described.

171. PROPELLER; Daniel Hughes, Rochester, New York.

Claim—The arrangement of the spiral screw propellers, so that their blades shall work nearly in contact, and thus present a broad, unbroken, resisting surface.

172. BELT-AWL AND PUNCH; Wm. J. Innis, Providence, Rhode Island.

Claim—The combination of the punch, awl, and spring handle, as described.

173. FASTENING FOR JAIL DOORS; Enoch Jacobs, Cincinnati, Ohio.

Claim—1st, Making the casings of heavy iron doors of double angle iron, as described. 2d, Fastening iron doors by swinging bars, working in the outside cavity of the double angle iron casing, in the manner set forth.

174. CHURN; Thomas A. Jebb, Buffalo, New York.

Claim—The arrangement of the short dash-blades and long dash-blade relatively to each other and to the segmental stave, so that the short dash-blades will revolve within, and the long dash-blade under, the lower beveled end of the segmental stave.

175. SEEDING HARROWS; Arthur E. Jerome, Monroeville, Ohio.

Claim—1st, Making the axis on which the harrows rotate hollow, and in the form of a drill-tooth. 2d, Combining a corn planter or a broadcast sower with the harrows.

176. PLOUGHS; W. T. Jones, Joliet, Illinois.

Claim—The attaching of the mould-board, land-side, and share, to the standard, by means of a joint or hinge, the plates or leaves of which are provided with screws, and arranged as set forth. Also, constructing the standard with a forked upper end, in connexion with the rod, lug, and flanch, arranged to admit of the proper attachment of the beam and handles to the plough.

177. BILLIARD TABLE; J. G. Kappner, City of New York.

Claim—The combination with the cushion rail of the circular guide plate, pivoted cross-arm, and hook, as described.

178. MACHINE FOR RABBETING WOODEN SOLES FOR SHOES; John Kimball, Boston, Massachusetts.

Claim—1st, The combination of the convex guide rest with the pressure roller and feed roller, arranged as set forth. 2d, In combination with the rotary cutters and feed rollers, the fixed tool, in the manner set forth.

179. HARVESTERS; William A. Kirby, Buffalo, New York.

Claim—Locating the raker's seat over the open space at the side of the platform, so that the delivery may be at any point along the whole side of said platform that the raker may desire.

180. BEER PITCHER; William S. Mathews, Meriden, Connecticut.

Claim—A pitcher with two strainers, one at the bottom and the other at the top of a partition.

181. EXTENSION TABLE; Louis Meyer, Columbus, Georgia.

Claim—The beveled arms or braces, central cross-piece, and stops, on the brace arms.

182. Mode of Operating Brakes on Railroad Cars; David Mumma, Jr, Harrisburgh, Pennsylvania.

Claim—The employment of the movable plate provided with a shoe, in combination with a friction wheel, n, a lever, and wheel, a, so arranged that friction from said shoe and plate may be applied, in the manner set forth. Also, the arrangement of the brake chain attached to the axle, so the said axle may be employed as a lever.

183. Potato Harvesters; J. D. Otstot, Springfield, Ohio.

Claim—The arrangement and combination of the bent lever, excavator, rotary rake, hopper, and driving wheels, in the manner set forth.

184. Machine for Making Wooden Boxes; George F. Palmer, Farmington, New Hampshire.

Claim—1st, The arrangement of the cutters, in combination with the stationary saws and with the adjustable saws. 2d, The employment of the expanding sliding platforms, arranged in combination with the saws.

185. Washing Machine; John Patton, Arcadia, Indiana.

Claim—The spiral springs, clamp, and the hook, in combination with the groove in the cylinder, poles, chains, cross-piece, rollers, board, compound wringer and rinser, and cylinder, when operated as described.

186. Cultivators; Isaac N. Pyle, Decatur, Indiana.

Claim—The arrangement and combination of the curved, pivoted wing rods, curved adjustable central rod, looped sockets, vertical movable standards, rods, braces, and handles, as described.

187. Machine for Cutting Tenons; J. R. Perry, Port Clinton, Pennsylvania.

Claim—1st, The combination of the right and left-hand screw with the cutter heads, in the manner set forth. 2d, Constructing the cutter bits with lugs to receive the shoulder bits, as specified.

188. Egg-beater or Ice-cream Freezer; John Pyne and Washington Barr, Harrisburgh, Pennsylvania.

Claim—The ice-cream freezer or egg-beater, the bottom having corrugated, perforated circles, in which the shaft and wires of the dasher revolve, as described.

189. Apparatus for Elevating Cannon; George M. Ransom, of the United States Navy.

Claim—The application of trunnions and bearings, or equivalents, to the nut, in combination with jointing or hinging the upper end of the upper screw to the cascable, or to a saddle attached to or supporting the cascable. Also, the combination of the cascable saddle with the elevating screw and cascable of the gun.

190. Lath Machine; John H. and Albert E. Redstone, Indianapolis, Indiana.

Claim—1st, Operating the knife plate by the sliding bar and groove or yoke, in combination with the roller attached to the knife plate. 2d, The guides, roller, slide, pins, and slots, combined as set forth.

191. Bakers Ovens; Nathan F. Rice, New Orleans, Louisiana.

Claim—A series of ovens placed on different floors of a building, and heated successively by products of combustion, directed and controlled by the described combination of flues, dampers, and air chambers.

192. Letter Envelope; Albert C. Richard, Newtown, Connecticut.

Claim—A letter envelope, having the properties fully set forth.

193. Billiard Table Cushion; George D. Sharp, City of New York.

Claim—The combination of the hollow cushion with a square or slightly beveled face for the ball to impinge against, thus producing a spring of greater ductibility than other billiard table cushions have.

194. Form-iron for the Use of Shoemakers; S. A. Shurtleff, North Carver, Massachusetts.

Claim—The adjustable beading plate, applied to a stock and arranged as specified.

195. Sewing Machines; E. C. Singer, Port Lavaca, Texas.

Claim—The feed device, the essential features of which are the plate, the block, and the lever and stop, operated by the grooved sliding bar, arranged in the manner set forth.

196. Billiard Register; Ferdinand M. Sofge, Macon, Georgia.

Claim—The arrangement of springs, operated by means of cylinder, A, upon tally, d. Also, in combination with the above, the cylinder, c, in connexion with the tally, 1 and 2, or any number of tallies and springs.

197. Pouncing Hat Bodies; W. H. Tupper, City of New York.

Claim—The employment of an air blast to cleanse and hold the body within the hollow cone, while the said body is being rotated and pounced.

198. Ploughs; John T. Townsend, Brenham, Texas.

Claim—The arrangement and combination of the land-side, standard, mould-board, share, braces or arms, and cross-bar.

199. Machines for Inserting Eyelets; William H. Rodgers, City of New York.

Claim—A single punch, operated as described, in combination with the connexion lever, cutter, and yielding spring guide point.

200. Portable Pump; William T. Vose, Newtonville, Massachusetts.

Claim—An improved pump, constructed with a barrel and the foot-stand or rest, arranged together as described.

201. Mode of Advertising; Edward Weibe, Brooklyn, New York.

Claim—The described mode of exhibiting advertisements, operated automatically.

202. Signal Bell; Joseph A. Woodward, Philadelphia, Pennsylvania.

Claim—The lever escapement bar, with the elliptical slot and projecting point, in combination with the projecting point of the hammer or striking arm.

203. Steam Pumping Engines; William Wright, Hartford, Connecticut.

Claim—1st, The application of the forked yoke, inclined arms, and levers, in conjunction with an independent hydraulic cylinder or engine, for working the valves of a steam engine properly, opening and closing them, and effecting the cut-off at the proper points, and performing all the offices and obtaining all the useful results of a well regulated and effective valve gearing. 2d, The combination of the forked frame and inclined arms for controlling and regulating the length of stroke between certain points on the faces of said planes, and graduating it between these points at the will and pleasure of the engineer, so as to reduce the clearance

in the steam cylinder to a minimum. 3d, The manner in which the main valve of the hydraulic cylinder is brought into action at proper and fixed intervals, and working the steam valves of the engine independently of the forked frame and its inclined arm, should the latter part of the gearing fail, from any cause, to assist in performing their duty. 4th. The application of the auxiliary valve, in combination with the main valve of the hydraulic cylinder, for effecting, at the proper point, the opening of the steam valves instantaneously and ahead of the steam piston; or in other words, for giving the lead to the valve as effectually as an eccentric will on a crank engine, and forming a cushion for the piston at the end of the stroke, reversing the movement and holding the valves wide open until the cut-off is accomplished. 5th, The mechanism for accomplishing, positively, the cut-off and insuring the closing of the valves, and in connexion therewith, the method of regulating and adjusting the same to any required point of the cut-off that the beneficial working of the engine may demand.

204. Pumps; William Wright, Hartford, Connecticut.

Claim—1st, The construction of the pump by the application of an auxiliary barrel to the working or brick barrel, and connecting both barrels by a double beat valve, thus effecting a combined opening through the auxiliary and the bucket valves, with a minimum lift of said valves greater than the area of the pump itself, and obviating to a great degree the frictional resistance that would be produced by passing all the water through the pump bucket valves alone, preventing all throttling, and permitting the engine to work more regularly and economically. 2d, The placing of one pump above the other, and connecting both together, and passing the load of one through the working and auxiliary barrels, and the bucket and auxiliary valves of the other, and vice-versa, thus allowing the engine to have complete control over the column of water.

205. Mode of Telegraphing; Samuel K. Zook, City of New York.

Claim—The construction of the telegraphic lines of metallic conductors of a high conducting power, having the portions of the wire conductors which are between the two telegraphic extremes in the earth, or submerged in the ocean or rivers, not artificially insulated, but using the earth or water as the natural insulator of those parts, in combination with the artificially insulated portions of the wire on each or either side of the battery or batteries.

206. Machinery for Drying Cloth; Charles F. Bennett, Warehouse Point, Assignor to Julius H. Baker, East Windsor, Connecticut.

Claim—The extra adjusting vibratory arrangements, whereby the cloth can be spread and straightened on the selvage while passing over the rollers.

207. Harvesters; John Butter, Buffalo, New York, Assignor to J. A. Saxton, Canton, Ohio.

Claim—The combination of the shoe with hinged and adjusting rods, plate, and cup, arranged as set forth.

208. Tempering Steel Wire; Wm. Darker, Jr., West Philadelphia, Assignor to J. B. Thompson, Philadelphia, Pennsylvania.

Claim—Combining the drum by which the steel ribbon or wire is drawn through the fire and bath, with the main or counter shaft, from which it derives motion, by means of a pair of cone pulleys or belt.

209. Making Clasps for Hoop Skirts; J. H. Doolittle, Assignor to Wallace & Sons, Ansonia, Connecticut.

Claim—Manufacturing metal clasps for fastening the tapes on hoop skirts, and for similar or analogous purposes, by cutting the scraps from the metal strips, so that the blanks will be attached thereto, and while thus connected, fed to the swaging or raising device, and swaged in proper form to produce the clasps.

210. Cocks for Water-closets; Darius Wellington, Assignor to C. Wellington, Boston, Massachusetts.

Claim—The employment or use of the valve and plunger, connected by the stem placed within a suitable cylinder, and arranged relatively with the supply and discharge pipes, to operate as set forth.

211. Curtain Fixture; Lewis White, Assignor to self and E. P. Miller, Hartford, Connecticut.

Claim—The application of the bracket and brake, in combination with the pulley, cord, and pendant lever, thus forming a double brake.

212. Machine for Bundling Kindling Wood; Wm. L. Williams, Assignor to self and Thomas J. O'Connor, City of New York.

Claim—1st, The follower, acting to lift a bundle of wood through a ring or opening, and separate the same from the mass of split kindling wood in the trough. 2d, The ring separator or the knife, acting to split or separate from the mass of kindling wood a bundle. 3d, The combination of the follower and ring separator or knife, in the manner set forth. 4th, Two or more slides with curved ends, acting against and on opposite sides of a bundle of kindling wood to compress the same previous to being secured by a wire or string. 5th, The compressing levers, in combination with the slides to act in compressing the bundle of wood. 6th, The twisting jaws or pincers, fitted to receive the wire in the manner specified, so that the act of revolving said jaws to twist the wire shall first draw the wire tight. 7th, The weight hung on the levers and acting to bring the ends of the wood level.

213. Rotary Engines; Henry C. Rice, Worcester, Administrator of the estate of John H. Hathaway, deceased, late of Milbury, Massachusetts.

Claim—The combination, with the cross-head which carries the abutment or cylinder head, of the rock shaft, the toggle, and the vibrating arm, applied and operating as described, in combination with the guide arms. And in combination with the above-mentioned rock shaft, I claim the arm, slide, lever, and eccentric, applied to produce an intermittent or remittent motion of the said rock shaft.

214. Type-setters and Distributors; Thomas W. Gilmer, Charlottsville, Virginia, Administrator of John B. Gilmer, deceased, late of same place.

Claim—Withdrawing the type from the type-case and setting them in line in the composing stick, without the aid of intermediate carrying mechanism, but by the direct application of the composing stick to the type-case. Also, distributing the type to the type-case by the direct application of the distributing stick to said case. Also, in combination with the type-case and the holding dog, arranged and operated so as to retain the type as they descend opposite the mouth of the case, and release the type when the mouth of the composing stick is in position to receive them. Also, arranging the type-case, so that, by a retrograde movement of the case, the type is discharged into the composing stick. Also, in combination with the composing stick, the spring mouth-plate to hold the type as they enter the stick. In combination with the spring mouth-plate, I claim the lip, l, arranged to assist in withdrawing the type from the case, and to prevent their turning or falling out of the composing stick as they are withdrawn from the case. Also, discharging the type into the case through the bottom of the distributing stick. Also, in combination with the distributing stick, a separating and discharging mechanism to the type, arranged so as to separate the front type from the rear, and from them into the type-case.

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215. CLOCK ESCAPEMENT; Charles J. Addy, Roxbury, Massachusetts.

Claim—The independent gravity pallet, pivoted to a fixed bearing, in combination with a recoil pallet swinging with the pendulum.

216. METAL-PLANING MACHINES; Moses Allan, Utica, New York.

Claim—1st, The construction of the apparatus shown, and its adaptation to the use of the ordinary planing machine, and its combination therewith. 2d, The combination of the bearing stands and the disc with the carriage of the machine, connected and arranged as described.

217. COMBINATION STEAM GAUGE; E. G. Allen, Boston, Massachusetts.

Claim—The combination and arrangement of the several instruments requisite to enable the engineer to regulate the proper working of steam machinery, as set forth; the said instruments being inserted in one case, and having the hands or other indicators upon one face or dial plate, in the manner specified.

218. WASHING MACHINE; Samuel Barber, South Brunswick, New Jersey.

Claim—1st, The combination with the lever, for operating the frame, of a curved extension guide for adjusting the frame, in the manner set forth. 2d, The arrangement with the above, of the serrated arc on top of the dash-board, for adjusting the inclination of said board.

219. BEE-HIVES; Eli Bartholomew, Cleveland, Ohio.

Claim—The arrangement of the outer casing and the inner casing, in relation to each other, and the ventilating openings in cover, which cover is furnished with a top and boxes.

220. SAW-SET; Jerred Beach, Freeport, Pennsylvania.

Claim—The arrangement of the guide with slot, levers, connecting link, and set-screws, used in connexion with the gauge, graduating rest-plate, regulating screw, anvil, and set, arranged and constructed as described.

221. AUTOMATIC CANAL BRIDGES; D. Berry, Huntington, Indiana.

Claim—The bridge, arranged to work on inclined ways, and connected by a chain and wheel to a shaft, which is connected, by gearing, to segments in line with the bridge and the boat, so that the former can be actuated by the movement of the latter.

222. WASHING MACHINES; Milton B. Bishop, Whitingham, Vermont.

Claim—The means of operating the two wash-boards, viz: the arrangement and application of the two sets of levers or brakes, together and with respect to the wash-boards, disposed one over the other and in the tub. Also, in combination with the upper wash-board and its brake, the rock shaft, the slide bar, and the springs, meaning also to claim the combination of the said rocker shaft, the slide, and springs.

223. COMPOSITION CEMENT OR MORTAR; Wendlin Bieser, City of New York.

Claim—The mortar described, made and employed as set forth.

224. LADIES BUSTLES; Joseph W. Bradley, City of New York.

Claim—A bustle consisting of a waistband, composed in parts of strips of metal, or other elastic material, and a spiral spring, tapered from the middle towards each end, applied to and combined with such waistband.

225. STEAM VALVES; Lockwood B. Brooks, City of New York.

Claim—Rendering the two parts of the balanced puppet valve, adjustable, relatively to each other, by connecting the stem to the sleeve by the yoke, arranged in the manner set forth.

226. ROAD-SCRAPERS; George and David C. Caward, Prattsburgh, New York.

Claim—The reversible, revolving, and adjustable blade, with the adjusting boxes, made and operated as specified. Also, the circular arms with the wheels, made as specified.

227. BAGASSE FURNACES; A. J. Chapman, Bayou Goula, Louisiana.

Claim—1st, The employment of the central air-heating chamber, having discharge passages leading into the furnace in its sides, and a central descending flue, in combination with a double-walled furnace having an air-heating chamber between its walls, and discharge passages through its inner wall, leading into the fire-chamber. 2d, The combination of the partitioned and valved air-heating chamber, between the walls of the furnace, with the upper and lower hot-air passages and mixing chamber. 3d, The combination of the auxiliary valved flue, leading directly to the chimney, with the valve, boiler-flue, and the furnace. 4th, The combination of the valve in the hopper with the cylinder feeder, carrier drum, cam, and lever, as set forth.

228. APPARATUS FOR GENERATING ILLUMINATING GAS; Matthias P. Coons, Brooklyn, New York.

Claim—1st, The particular form and manner of constructing and combining a gas-generating retort, consisting of a fusion chamber and barrel, as represented. 2d, The diaphragm, J, in combination with the chambers, F and D, and diaphragm, N, in the manner specified. 3d, The chamber, H, constructed in combination with the other apparatus specified. 4th, The chamber, K, as attached to the cover, in connexion with the escape pipe, with a stop-cock attached, in the manner specified. 5th, In combination with the apparatus specified, the projecting ridge on facing rim or flanch, and the corresponding groove in the door; also, in combination, the yoke or bar and crank screw, as combined, and also the hook hinges, as set forth.

229. CHILDREN'S SLEDS; Benjamin P. Crundall, City of New York.

Claim—Connecting the head and neck of the horse to the bottom, or in front thereof, of the child's sled, having spring or other runners, in such a manner that the pole may be secured under the bottom of the sled.

230. LOCOMOTIVE ENGINES; Edward Crane, Dorchester, Massachusetts.

Claim—The combination, in a locomotive, of a boiler and engine, with a water tank, coal box, blower, and baggage department, on one long truck frame suspended underneath the axles of the wheels.

231. RAILROAD CARS; Edward Crane, Dorchester, Massachusetts.

Claim—The use of a single long truck for the support of a railroad car, when the frame of said truck is constructed and suspended as described. Also, the use of cylindrical bars of iron, passing under the frame of the truck, and nearly in contact with the rails, for the purpose of keeping the truck frame from striking the rails or ground in case the cars leave the track.

232. HARROW TEETH; D. M. Cummings, Enfield, New Hampshire.

Claim—1st, Constructing the tooth of a harrow with prongs and sharp-pointed shields, as specified. 2d, In combination with the above, the wedge-shaped plate, in the manner described.

233. LAUNCHING FLAT BOATS; John and Ebenezer Davis, Matildaville, Pennsylvania.

Claim—The combination of the hinged projection beams with the shoulders, pulleys, and ropes, as set forth, when used in connexion with the permanent staging.

234. APPARATUS FOR SUPPLYING SAW-DUST TO FURNACES; Harrison Doty, Cardington, Ohio.

Claim—The employment of the latch, arranged to operate as in the manner set forth. Also, the arrangement of the hinged bottom provided with the adjustable weight, with the latch provided with adjustable weight, and with stationary box.

235. WAGON JACKS; Charles Douglas, Hebron, Connecticut.

Claim—1st, The combination and arrangement of the lever, pawl, ratchet plate, rod, and stock, as described. 2d, The pawl, when used for the double purpose of a pawl on the ratchet plate, and a fulcrum for the lever.

236. GRAIN-BINDERS; C. H. Durkee, Hartford, Wisconsin.

Claim—1st, The combination of the traveling segment, jointed arm, its rod, connecting rod, and rack, operated by pinion and rack. 2d, The swinging rack, in combination with the traveling segment for receiving and holding the pinion while the end of the arm is being passed through the loop. 3d, The loop-holder, trip-block, and block, arranged as set forth.

237. VULCANIZING RUBBER COMPOUNDS; Asahel K. Eaton, City of New York.

Claim—The use of a metallic bath, as described.

238. CABBAGE-CUTTING MACHINE; Gustavus G. Elias, Lancaster, Pennsylvania.

Claim—The specific arrangement and combination of the sliding box, with its notches, flat spring, and retaining plates, the double coned spiral spring, with its square bottom and armed top, the counter cutting knives and central division on the table, provided with legs; the wheel, crank, or connecting rods, made as specified.

239. COTTON PRESSES; E. A. Elliott, Port Gibson, Mississippi.

Claim—1st, The employment of the hinged forms forming part of the box, in combination with the follower, R, said forms being so arranged as to receive the cotton and to act as guides for the follower. 2d, The employment of the weighted follower, R, in connexion with the spring bolts, whereby the loose cotton is instantly, at the proper time, brought down and held in the proper space, to be acted on by the followers, F. 3d, The arrangement of the doors with reference to the box and the position of the bale therein, when fully compressed, by means of which I am enabled to apply and secure the covering without sewing. 4th, The arrangement of the rod and stops with reference to nut and its movement, whereby the clutch is not only disconnected from the pulleys at the proper times, but also prevented from connecting by accident or otherwise, as described.

240. COMPOUNDS OF CAOUTCHOUC AND ALLIED GUMS; George August Engelhard, City of New York, and Rudolph Franz Heinrich Havemann, New Brunswick, New Jersey.

Claim—The described product, obtained by the action of chlorine on gums, such as india rubber or gutta percha, whether in solution or in substance, in either of the modes pointed out, or in any other that is substantially the same, and which will produce a like effect.

241. SAW-MILLS; A. J. Emlaw, Grand Haven, and Elliott Richmond, Kelloggsville, Michigan.

Claim—1st, The arrangement of the friction wheel and pulleys in connexion with the shafting, for the purpose of giving the feed and gigging back movement to the carriage, as set forth. 2d, The arrangement of the adjustable bars on the carriage, screw rods, and adjustable wheels on shaft, whereby the bars may be adjusted nearer to or further from each other, to suit the length of the stuff to be sawed.

242. RUBBER BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—Machine belting or banding, manufactured with surfaces of india rubber or gutta percha, and having surfaces which are as nearly as is practically possible perfectly smooth, as described.

243. MAKING RUBBER BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—The method described for manufacturing machine belts or bands of india rubber or gutta percha, by rolling them in thin sheets of flexible metal and then heating them.

244. HARROWS; Oliver C. Green, Dublin, Indiana.

Claim—The described arrangement of the harrow teeth, beams, wheels, arms, lever, rods, and rack, constructed in the manner set forth.

245. COTTON HARVESTERS; John Griffin, Louisville, Kentucky.

Claim—The employment or use of annular chambers communicating with the cups of the suction tube or tubes, by means of perforations, and communicating with a steam or air chamber by means of flexible tubes, as set forth.

246. GRAIN SEPARATORS; P. Griswold and H. H. Seeley, Hudson, Michigan.

Claim—The combination with the screen to form the rocking bar and vibrating bar, as described.

[The invention consists in giving the lowermost screen in the shoe of the separator a compound movement, and using in connexion therewith a supplemental screen having a vertical movement only.]

247. EVAPORATING VESSELS; John P. Hale, Kanawha, Virginia.

Claim—The superheating of the steam or vapor arising from the evaporation of the brine, as described.

248. CARRIAGE TOPS; A. J. Hall and Russell Patton, Morristown, Vermont.

Claim—The construction of bows for folding carriage tops with joints, as set forth.

249. FERTILIZERS; Louis Harper, Riceville, New Jersey.

Claim—1st, The preparation of the peat, or muck, or lignite, and their mixture with sulphate of lime, soda, potash, and magnesia, when required to form the bases of the preparation intended for composition of the fertilizer. 2d, The addition of phosphate and bi-phosphate of lime to the above bases, and the impregnation of the above mixture with ammonia, in the manner described, so as to be converted into simple and double salts, as above stated. 3d, The combination of peat, or muck, or lignite, prepared as described, with green sand marl.

250. DOOR-FASTENING; Lewis G. Hoffman, Waterford, New York.

Claim—The described button, as a new article of manufacture.

251. CUT-OFF ARRANGEMENTS FOR STEAM BOILERS; Julius Hornig, Newark, New Jersey.

Claim—The employment, for opening and controlling the closing of the cut-off valve, of a revolving and swinging cam, applied in combination with and operated by a revolving wrist-plate and a grooved disc, as described.

252. PROPELLING WHEEL; Joshua L. Husband, Philadelphia, Pennsylvania.

Claim—The combination of the guides, the arms, the connecting rods, the double cranks, and the sectional paddles, operating together in the manner described.

253. COAL HODS; R. W. Huston, Calais, Maine.

Claim—The arrangement of the bucket with the external casing, when the bucket is provided with a rim or flanch around its top, and with a pin on its bottom, upon which it revolves, and when the external casing is provided with a top which fits snugly around the bucket and over the rim or flanch with a channel, and with a door to said channel, as specified.

254. DITCHING MACHINE; George E. Inman, Buffalo, New York.

Claim—1st, The cutter, arranged and operating as set forth. 2d, The arrangement of the adjustable roller, under the elevated part of the share. 3d, The arrangement of the caster-wheel, plough, cutter, adjustable roller, plough-share, and side pieces, relatively to each other, as described. 4th, The arrangement of the two driving wheels on the same shaft, when placed so near together as to track within the ditch cut by the horizontal share.

255. ROTARY STEAM ENGINES; Luther Johnson, Grand Ledge, Michigan.

Claim—1st, The employment, in combination with a sliding abutment fitted to the outer stationary cylinder, of an inner revolving cylinder, having a concentric groove or channel closed permanently in one place by a piston extending all across it, as described. 2d, Operating the abutments and the cut-off valves by means of the same cams, through the agency of rollers applied to the abutments and yokes, rods and levers, and arms, n n, applied to the cut-off valve, arranged as described. 3d, The two sliding reversing valves, applied in combination with the two sets of steam-pipes in relation to the abutments, and operated simultaneously by a single lever, as described.

256. OX YOKES; H. P. Judson, Bethlehem, Connecticut.

Claim—The arrangement of the peculiar rotary spring disc, curved rods, and horizontally moving locking bolts, as described.

257. LATHE ATTACHMENT; Cheney Kilburn, Burlington, Vermont.

Claim—The rotating reciprocating knife, in combination with the carriage provided with the gouging tool and V-shaped cutter, pattern, recess, and support, arranged as set forth.

258. MANUFACTURE OF PARAFFINE CANDLES; Elisha C. Leonard, New Bedford, Massachusetts.

Claim—My process of treating paraffine in the manufacture of candles therefrom, whereby I am enabled to dispense with a refrigerating air bath cooled by artificial means, my improvement or invention consisting in the employment, in manner described, of the atmospheric temperature and the refrigerating water bath, after the first cooling of the candle in the water bath.

259. RAILROAD CAR AXLES; Edward J. Mallett, City of New York.

Claim—The combination and arrangement of the parts, as represented, for the purpose of forming an axle on which the wheels shall have an independent motion, constructed as described.

260. TRACTION LOCOMOTIVES CARRYING THEIR OWN RAILWAY; Charles F. Mann, Troy, New York.

Claim—So applying the endless chains as to make them not only the track for the supporting wheels of the locomotive to run on, but also the means by which the engine propels the locomotive along the ground.

261. FERTILIZERS; James J. Mapes, Newark, New Jersey.

Claim—The production of a fertilizer by combining guano and sulphate of ammonia, or its equivalent, with burnt bones, or their equivalents, when the said bones, or equivalent, have been treated by sulphuric acid, as specified, prepared in the manner set forth.

262. SCYTHE-RIFLES; Thomas J. Mayall, Roxbury, Massachusetts.

Claim—A rifle for sharpening scythes, &c., formed of india rubber or gutta percha, with which emery, sand, or other suitable gritty substances are incorporated.

263. HARVESTERS; William Morrison, Carlisle, Pennsylvania.

Claim—Providing the rear end of the finger with the open slot, whereby I am enabled to readily remove the stationary cutters and fingers, and to replace them without detaching the bolts or nuts which secure the fingers to the finger bar.

264. BOILERS FOR TREATING PAPER STOCK; Martin Nixon, Philadelphia, Pennsylvania.

Claim—The close spherical kier or boiler, journaled on hollow trunnions, and provided with a perforated floor, steam-pipes, and elevating and distributing pipes, constructed and arranged in the manner set forth, to boil paper-stock under a heavy pressure, by the combined action of an upward current of steam and a downward current of hot alkaline solution, and admitting of the ready inversion of the said boiler for the discharge of its contents when cooked.

265. VAPOR LAMPS; John K. O'Neil, Kingston, New York.

Claim—The arrangement of the auxiliary burner in connexion with the gas generating chamber, in such a manner that a cessation of its action on said chamber may at any time be effected without extinguishing its light by the separation of said burner from its influence on said chamber, as described. Also, the spiral revolving shade, in combination with the auxiliary burner, as described. Also, the construction and arrangement of the burner and graduating tube, in combination, as described.

266. SEWING MACHINES; William Pearson, Windsor Locks, Connecticut.

Claim—The combination of the vibrating looper, the cam flanch which operates it, and the vibrating bar carrying the friction rollers, arranged as set forth.

267. MANUFACTURE OF PAPER PULP; J. B. Palser and G. Howland, Fort Edward, New York.

Claim—The boiling of the straw or other stock for about four hours, under a pressure of from 110 lbs. to 130 lbs., in a solution of caustic alkali, of a strength indicating from 3½° to 3¾° Beaume, in the manner set forth.

268. Horse Power Machines; Wm. Phelps and W. H. Hanford, Sycamore, Illinois.

Claim—The combination and arrangement of the wheels and rollers on truck, and wheel and friction rollers on track, and friction rollers on rotary track, with rotary drive wheel and friction rollers, constructed as described.

269. Elastic Enema Syringes; Francis B. Richardson, Boston, Massachusetts.

Claim—The improvement in india rubber syringes, which consists in combining the india rubber or gutta percha, or other water-proof bag, with the suction end of the syringe, in the manner described.

270. Sewing Machines; T. J. W. Robertson, City of New York.

Claim—1st, The employment, in combination with the needle of a sewing machine, of a plate, constructed as described, for the purpose of laying and holding braid, gimp, or other material, upon the surface of the fabric. 2d, The arrangement of the guides to extend past the centre and on each side of the needle-hole, as set forth. 3d, The employment, in combination with a braid-holder, of the adjustable slide, for the purpose of flattening and opening the braid and preventing its kinking.

271. Machine for Chamfering and Crozing Kegs or Casks; John A. Seaman, St. Louis, Missouri.

Claim—The rotating arms provided with the adjustable jaws, the adjustable rotating ring fitted to the annular plate by the screws and guides, the plate being provided with the tool-holding levers, attached to the guide shafts and supported by the springs, and the shafts connected to a treadle frame, combined to operate as set forth.

272. Guides for Sewing Machines; Lemuel W. Serrell, Brooklyn, New York.

Claim—1st, A spring tucker, acting to fold the edge of the hem against the plate of the hemmer when combined with the adjusting screw, whereby the pressure of the tucker on the goods and the opening or mouth left for their passage are regulated. 2d, The horn, in combination with the tongue, as specified. 3d, The arrangement of the hem-spreader stock and gauge, as specified. 4th, Attaching the guide or hemmer to the sewing machine by a cylindrical pin or hinge, to permit the said guide or hemmer to be turned up or inverted, so that the edge of the cloth, at the beginning of the hem, can be properly entered and folded while in this position.

273. Grain Separators; Daniel Spencer, Courtlandt, New York.

Claim—The combination with a grain separator between the fan shaft and the separating screens of a shaft and a series of sliding wheels, as set forth.

274. Composition for Protecting and Ornamenting the Surface of Wood; John F. Stark, Greensburgh, New York.

Claim—The employment of a compound composed of sulphur and alcohol, or sulphur and the alcoholic varnish described, in the proportions and manner described.

275. Apparatus for Regulating the Pressure of Water in Pipes; James Stratton, Brooklyn, New York.

Claim—The employment or use of the air chamber, diaphragm with valve, c, attached, the pipe, B, containing valve, o, and communicating with the air chamber by pipe, F, provided with the cocks, and the pipe, e, communicating with the pipe, F and B, arranged in relation with each other and the supply pipe, A, as set forth.

276. Apparatus for Elevating Water from Wells, &c.; L. Taylor, Jordan, Wisconsin.

Claim—1st, The employment or use of the springs, arranged in connexion with traveling jackets and receivers, as set forth. 2d, The means of connecting the bucket to the carriage, to wit: the lever on the carriage, provided with the loop, and the bail of the bucket with its pulley, in connexion with the pulleys on the carriage, and the taper rod and catch in the well-house, whereby the bucket is drawn up the wire or way, and dropped and raised from the well.

277. Air-heating Pipes for Blast Purposes; Samuel and John Thomas, Cattasauqua, Pennsylvania.

Claim—Supporting both of the legs of the arched pipes upon one bottom tube, so that injury to said pipes by the displacement of the bottom tubes will be prevented; and so that each bottom tube, with its connected arched pipes, may be removed and replaced, without disturbing any of the remaining arched pipes or bottom tubes.

278. Propeller Wheel; Thomas Tripp, Buffalo, New York.

Claim—A propeller wheel, having blades formed in respect to their main propelling surfaces, and also in respect to their outward arcs, as described.

279. Washing Machine; David Walling, Garrettsville, New York.

Claim—The combination of weighted arms, jointed connecting rod, H, angular lever, rod, a, vibrating dash-board, K, and dash-board, M, arranged as set forth.

280. Washing Machine; M. D. Wells, Morgantown, Virginia.

Claim—The reciprocating plunger, operated as described, in combination with the rack piece moved by the plunger, in its backward motion, and springs throwing said rack in place.

281. Cultivators; J. Whiteside and H. F. Crabill, Fuller's Corners, Indiana.

Claim—1st, The arrangement and combination of the hinged, curved shovel beams, cross-bar, and gaging wheel, as set forth. 2d, The curved draft beam, arranged as described, in combination with the cross-bar, handles, and rod.

282. Washing Machine; R. G. Wilkins, Burns, New York.

Claim—1st, The combination of an upper rotary rubber with revolving slats, with two or more lower rotating rubbers with revolving slats, arranged as described. 2d, Arranging the undulating surface of the slats in the upper rubber, so the projections come opposite to each other throughout, when the same is combined with a lower rotating rubber in which the projections of one slat are arranged opposite the depressions in the adjacent slats, and also when the slats of the upper rubber are arranged in relation to the slats of the lower rubber, as described.

283. Washing Machine; John Williams, Ashfield, Massachusetts.

Claim—The combination of straight fluted rollers, placed in the box of the machine in the form seen in the model, and two arms connected by a handle at one end, and attached by the other to the extremities of the frame which holds the four rollers.

284. Floating Batteries; E. A. Willis, Cold Spring, New York.

Claim—The combination of the central upright shaft, so applied that it may serve to anchor the battery

and that the battery may revolve around it, and a system of propellers by which the battery may be either caused to revolve around the said central shaft while at anchor, or propelled from place to place, when the said central shaft is elevated.

285. Disengaging Hook for Liberating Ships Boats; T. W. Wilson and Lewis Raymond, City of N. York.

Claim—The combination of a detachable hook, consisting of an open eye and pin combined with each other, as set forth, with a pulley block for lowering a boat. Also, the combination of a detachable hook with the davit, or object from which a boat is lowered by means of a lanyard, that is independent of the lowering tackle, in such manner that the combination as a whole operates to free the boat from the tackle by the taughtening of the lanyard.

286. Lining Tanks for Fatty Acids; Michael Werk, Cincinnati, Ohio.

Claim—The lining of the tank or metal vessel used with wood and cement, in the manner set forth.

287. Cheese Vat; C. M. Wilkins, Madison, Ohio.

Claim—The arrangement of the valves within the water chamber and vat, as described.

288. Manufacture of Nitrate of Silver Crayons; Sylvester P. Wheeler, Assignor to Moses H. Wheeler & Co., Bridgeport, Connecticut.

Claim—The manufacturing or forming of sticks or pieces of nitrate of silver or lunar caustic, with one or more wires or ribbon of metal running through the same, to which the nitrate of silver or lunar caustic adheres, and still holds to the wire, wires or ribbon, when used or otherwise, when broken.

289. Centrifugal Water Wheels; Harry Abbot, Assignor to self and Emerson Abbot, North Huron, Ind.

Claim—The combination, with a centrifugal water wheel, of a valve, located and arranged within said wheel so as to turn with it, and, at the same time, be adjustable while the wheel is in motion, by means of the bail, concentric, and adjusting lever.

290. Machines for Raking and Loading Hay; J. A. Althouse, Philipstown, Illinois, Assignor to self and F. W. Lechtenberger, New Harmony, Indiana.

Claim—The combination of the stationary rake, C, revolving rake, I, and vibrating rake, K, placed on a mounted frame, and arranged as set forth.

291. Churn-dasher; Gillett Bunting, Assignor to self and W. M. Jarrell, Liberty, Indiana.

Claim—Producing the vibratory movement in the cylindrical churn-dasher, by means of the combination of said arms with the crank portion of the driving wheel and intermediate connecting rod, when these are used in connexion with the current-breaker.

292. Mangle; James T. Coxell, Assignor to self and Edward Jones, Brooklyn, New York.

Claim—1st, The arrangement of the rollers above the table, so that the fabric will be folded by the machine. 2d, The combination with the weighted levers of the lifting ropes, so that the downward pressure of the roller may be released, and the roller lifted at the will of the operator to allow such portions of the linen that have buttons or other elevations to pass through the machine uninjured.

293. Bed Bottom; H. E. Fickett and John W. Summers, Assignors to H. E. Fickett, aforesaid, Glenn's Falls, New York.

Claim—The arrangement of the slats with the spiral springs, wires, central supports, and cross-brace, arranged in the manner described.

294. Coffee Pots; Horatio P. Gatchell, Ravenna, Assignor to E. J. Bates, Bedford, Ohio.

Claim—The forming of the walls of the cups with male and female screws, in combination with the perforated bottoms, for the purpose of compressing the ground coffee and extracting the strength of the drug by displacement, in the manner specified.

295. Mode of Applying Steam as a Motor to City Railroad Cars; William Darker, Assignor to self and J. B. Thompson, Philadelphia, Pennsylvania.

Claim—1st, Placing a steam engine and steam generator on the top of a city railroad car, when the engine, by suitable driving mechanism, is connected with the wheels of the car, to propel the same. 2d, Connecting the governor with a throttle valve and brake, arranged as set forth. 3d, The particular arrangement of the brake formed of the strip on wheel, and actuated by the movement of the yoke on its bent ends, connected with the hand lever rod, so as to allow of the adjustment of the throttle valve by hand independently of the automatic connexion. 4th, The arrangement of the bar, A′, cam, lever, and rod, connected with the bar, A′, by the arm, whereby the brake is operated automatically.

296. Knitting Machines; Augustus J. and Demus Goffe, Cohoes, Assignors to Downs & Company, Seneca Falls, New York.

Claim—The rotary burr-presser, having inclined planes between the teeth, in combination with the sliding needles, arranged in the manner described. Also, varying the eccentricity of the groove, by means of the movable pulley, spring, adjusting screw, and friction pulley, in the manner described.

297. Method of Making Copal Varnish; Liveras Hull, Charlestown, Assignor to self and A. Wheeler, Boston, Massachusetts.

Claim—My new manufacture of varnish, as composed of gum copal, camphene, and alcohol, united in the proportions in a cool state, in a closed or air-tight vessel, as specified.

298. Treatment of India Rubber; Henry W. Joslin, Trenton, New Jersey, and A. K. Eaton, City of New York, Assignors to the Joslin India Rubber Company of New York.

Claim—The treatment of the argillaceous red shale of New Jersey, or other similar geological localities, in combination with sulphur and caoutchouc, in the manner and for the purpose described, for the manufacture of india rubber.

299. Sewing Machines; James S. McCurdy, Brooklyn, New York, Assignor to J. H. Myers, City of N. York.

Claim—The vibrating lever carrying the shuttle-driver, and provided with the spring, to keep the shuttle-driver to the raceway, constructed as specified.

300. Bed-bottom Spring; Henry M. Scott, Assignor to self and Samuel Adlam, Portland, Maine.

Claim—The employment of spring hooks and clamps, for the purpose of attaching strips of webbing to the frame of a bedstead.

301. Ore Separator; Parmenas P. Parkhurst, Princeton, Massachusetts.

Claim—The washing-box or chamber, constructed with the pipe entering near the bottom, to cause a whirl

and circulation, as specified, and with the gate or overflow, as described, and in combination with such washing-box, I claim the receptacle or box and chamber, to receive the metallic particles when the gate is raised.

302. PILING RAILROAD BARS FOR RE-ROLLING; John Thomas, Assignor to self and John M. Lord, Indianapolis, Indiana.

Claim—The tie No. 7, when used for interlocking T-rail, or other old iron, and forming the pile of six rails, arranged as set forth.

303. SHOE-PEGGING MACHINE; E. T. Weeks, Assignor to S. H. Babcock, Franconia, New Hampshire.

Claim—The feeding device formed of bar, L, to which the jaws are connected, operated by the screw, ratchet, pawl, lever, and pitman, as set forth. Also, in connexion with the riving or splitting knife, the gauge, arranged as specified. And further, the elastic or yielding bar, attached to the arbor, provided with cam, and used in connexion with the segment rack, curved bars, and jaws, for the purpose set forth.

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304. SLEEVE-FASTENERS; Reuben L. Allen, Providence, Rhode Island.

Claim—A sleeve fastening, composed of the spring, cylindrical arms, hinge and catch, and hooked bar.

305. WASHING MACHINE; Seth A. Andrus, Roscoe, Illinois.

Claim—1st, The combination of the circular plate or crank with the rubber, so arranged that, by operating the said crank, I am enabled to communicate to the said rubber at the same time, a vertical reciprocating motion and a lateral vibratory motion. 2d, The combination of the caster rollers with the double spring, arranged in connexion with the rubber.

306. COOKING RANGES; Evans Backus, Stuyvesant, New York.

Claim—Attaching to a stove or range the curved plate, and the movable plate, and the continuous flue, arranged in the manner set forth.

307. MAKING HUB-BANDS FOR WAGON WHEELS; G. W. Beers, Bridgeport, Connecticut.

Claim—Casting slits or holes through the bands sufficiently large to allow the solder, or other suitable metal used in connecting the cap to the band, to flow through them and unite them.

308. WATER-CLOSET BASIN; William Boch, Sr., Green Point, New York.

Claim—A water-closet basin, having a covered annular water passage at its upper edge.

309. MACHINE FOR REGISTERING MUSIC; Henry F. Bond, Hudson, Wisconsin.

Claim—1st, The application of the bell-pull action with knees and wires to act upon the markers. 2d, The arrangement of the lever, J J J and K K K, by which the sharps are marked with double lines on the spaces or lines in music, with their corresponding naturals, the levers or markers, K K K, being made each of two pieces of tin, or other metal, and the levers or markers, J J J, playing between those two pieces. 3d, The arrangement of levers or markers, of both kinds, in a row, with proper intervals to record the music or paper ruled as represented, the staves of music being ruled of one color, with just leger lines enough of another color to write directly up or down from one staff to another, the leger lines between the two staves belonging alike to both of them, and the whole number of lines and spaces being equal to the compass of the instruments. 4th, Application of the ink or coloring matter to the cylinder, and the producing of colored marks by pressing the paper against the inked cylinder. 5th, The action of the lever, E, upon the bar marker, after the manner set forth. 6th, The mode in which the loud pedal action is marked.

310. HUB-BORING MACHINE; S. L. Bond, Greenwood, South Carolina.

Claim—The V-shaped bars or jaws, in combination with the bit arbor, arranged as shown.

311. MAKING HUB-BANDS FOR WAGON WHEELS; James A. Boughton, Poughkeepsie, New York.

Claim—The combination of the flanch and projection on the leaf and the set-screw in the open band.

312. MACHINES FOR MAKING CHAIN; John Calvin Brown, Providence, Rhode Island.

Claim—The circular disc provided with the wedge-formed projections, arranged in combination with the bell crank levers, which operate the several bending instruments, such combination operating in the manner as described.

313. PAINT CANS; Peter Brown, Brooklyn, New York.

Claim—1st, The employment of a strengthening wire within the bead, as described. 2d, The combination of the pivoted ears with the cover, lug, and can, as described.

314. QUARTZ-CRUSHERS; T. S. Brown, City of New York.

Claim—The employment or use of the tubular pestle, having a reciprocating and rotating movement, in connexion with the nipple or cone in the box or mortar.

315. TOOLS FOR HANDLING TIRE; John and Henry Brubaker, Lancaster, Pennsylvania.

Claim—The rod-handled tong, with its sliding leg and hooked end, in combination with the ring, as described.

316. HARVESTERS; John P. Burnham, Rockford, Illinois.

Claim—The employment of a spring, in combination with the lever and connecting rod, as described.

317. HARNESS YOKE; Ze Butt, Lincolnton, North Carolina.

Claim—The manner of constructing and arranging the yoke, so that its weight, or the greater portion of it, may rest upon the back instead of the neck of the horses. Also, in combination with the yoke, giving a wide base to the line of draft, either by the bolt and clevis, or any other equivalent device, for the purpose described.

318. VEGETABLE-CUTTERS; Andrew J. Chapman, Scipio, New York.

Claim—The arrangement and combination of the hinged guard or feed-board, hinged follower, and stationary slatted cutting bed, constructed in the manner set forth.

319. POTATO-PARER; William B. Coates, Philadelphia, Pennsylvania.

Claim—The handle, ferrules, guard, and blade, arranged in the manner set forth.

320. GAS BURNERS; Seth L. Cole, Burlington, Vermont.

Claim—The construction, from some good conducting material, of a gas burner, with an enlargement of

the tube at the point where the gas is discharged, and burned in the form of a globe, or the like, furnished with a slot aperture, so that the gas shall be heated to the utmost at the point where it is consumed.

321. BREECH-LOADING AND OTHER FIRE ARMS; John Webster Cochran, City of New York.

Claim—1st, So constructing and applying one or more accelerating chambers, in combination with the plunger or elastic cushion, that the charge or charges in the accelerating chamber or chambers are fired by the driving back of the plunger or cushion, and that the plunger or cushion serves as a safety valve to the accelerating chambers. 2d, Combining the movable breech-piece, containing the plunger or elastic cushion, with a ring or circular frame hinged to a slide, which works longitudinally to the gun. 3d, In combination with the breech-piece, secured in place by a screw, or its equivalent, I claim the adjustable screwed bushing applied to the gun, as described. 4th, The combination of the plunger, accelerating chamber, volute spring, movable breech-piece, ring or frame, and slide.

322. COOKING RANGE; George Cooper, Concord, New Hampshire.

Claim—The combination and arrangement of the separating leading flues, A B C (each provided with a damper, arranged in it as explained), with flues, D E F G H, disposed around the oven. And in combination therewith, I claim the separate insulating flues, I K, arranged between the ovens, and on opposite sides of the leading flue, A, and made to open into the bottom flues, D and G, and to communicate with the flue, A, by openings provided with dampers.

323. BUTTONS; P. Davey, Ironton, Ohio.

Claim—The construction of the double flanched shank-piece as the basis of the button, forming on one end thereof a button and on the other a fastening, and in the middle two flanch guards, to receive the button hole and protect it from too much abrasion and friction.

324. PLOUGHS; A. A. Dickson, Anderson, South Carolina.

Claim—The arrangement of the peculiar shaped bar with the shares, beam, and handles.

325. DETECTIVE REGISTER FOR WATCHMEN; Patrick H. Duffy, Somerset, Ohio.

Claim—Dropping the balls, by which the action of the apparatus is indicated, into the cells of a revolving wheel, by operating a rod and slide, in the manner described. Also, locking and releasing the rod by devices described, whereby it can be pulled, at certain times only, to drop a ball into the cells of a revolving wheel.

326. MACHINE FOR CONVERTING RECIPROCATING INTO INTERMITTENT ROTARY MOTION; Henry Ehrenfeld, City of New York.

Claim—The plate, or its equivalent, arranged with a socket and cut or split through its centre, to operate in combination with the wheel and lever, which latter is furnished with an oblong pin, in the manner specified.

[This device is particularly intended to give motion to the feed-wheel of a sewing machine, and it is so arranged that it never fails to impart the required motion to the feed-wheel in one direction, while, in going back, it has no effect whatever on the same.]

327. JOURNAL-BOX FOR SAW-MILL CARRIAGES; William M. Ferry, Jr., Ferrysburgh, Michigan.

Claim—A single casting, moulded with an intermediate space, and with off-setting boxes on each side of said space.

328. RAILROAD HAND-CARS; Henry Fisher, Alliance, Ohio.

Claim—The manner of combining the hand crank-shaft with the axle of a railroad hand-car, so that, when the crank-shaft meets with any obstruction, it disconnects automatically from the axle and ceases its revolution with the same, and thus prevents a sweeping off of the operators from the platform.

329. MANUFACTURE OF RUBBER BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—The method described of imparting a smooth and finished surface to belts or bands of india rubber or gutta percha, the same consisting in placing them in contact with sheets or strips of vulcanized india rubber or gutta percha, and then vulcanizing them by applying heat.

330. MANUFACTURE OF RUBBER BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—The manufacture of belting or banding, composed either wholly or in part of india rubber or gutta percha, which consists in vulcanizing the belt or band, and giving it a smooth friction surface at one operation, by feeding the belt or band around or in contact with a series of smooth heated rollers.

331. BENCH VISE; G. A. Gray, Jr., Cincinnati, Ohio.

Claim—The described combination of the handle, loose head, and catch, with the jaws, screws, and endless chain of a parallel bench vise.

332. COMPOSITION FOR COVERING METALS; J. H. Green, Christiansburg, Iowa.

Claim—The composition described.

333. MACHINE FOR RIVING BASKET SPLINTS, &c.; William J. Horton, La Grange, Alabama.

Claim—The employment or use of the rollers, three or more, knife placed in the gate, and the guide plates, arranged as set forth.

334. TOY GUN; Josee Johnson, City of New York.

Claim—1st, So arranging the spring, D, relatively to the bore, A, that D is, by a single movement of the finger, used both as a trigger and a propelling force to discharge the projectile through A. 2d, In connexion with the above, receiving the impact of the spring upon the single bearing, so that the free portion of D moves by its momentum beyond its original position, for the purpose described. 3d, The detaching surface, arranged relatively to the spring lever and barrel.

335. RAILROAD SWITCHES; F. H. Joyner, Richmond, Vermont.

Claim—A pair of switches, in connexion with stationary bearing rails, as described.

336. MANUFACTURE OF VINEGAR; Bernhard Koegel, City of New York.

Claim—Converting wine, or other alcoholic liquors, rapidly into vinegar or acetic acid, by means of pumice stone, or its equivalent. Also, the tub or apparatus, as described, when pumice stone is used in the same.

337. APPARATUS FOR TAMING HORSES; J. M. Lamer, Eufaula, Alabama.

Claim—The employment of the straps, A A, loop, B, and straps, D C and E, arranged and used as specified.

338. GRAIN FANS; Oliver Lindsey and Robert F. Strean, Washington, Pennsylvania.

Claim—The combination of division boards with the inclined plane, the screen board, and riddles, united

in the peculiar manner described, and arranged to operate in the relation to each other, and to the currents of wind thrown off by the fan.

339. FILTERS; William Linton, Baltimore, Maryland.

Claim—Arranging a clamping plate, of less diameter than the filtering cylinder, on adjusting screws of the removable head of the cylinder.

[This cylindrical filter receives the water at one of its ends, changes the direction of the course of the same, and causes it to pass in opposite directions, then to take a course back through three layers of felt, which deprive it of all impurities before it escapes at the opposite end of the cylinder.]

340. VALVE GEAR OF STEAM ENGINES; Peter Louis, City of New York.

Claim—1st, The auxiliary cylinder, having a partition and arrangement of steam and exhaust passages, and fitted with a valve, or its equivalent, and with the two pistons on opposite sides of its partition, applied in combination with the induction and eduction valves and the shaft of the main engine, so that each of said pistons, acted upon by steam admitted to its compartment of the auxiliary cylinder by the valve, serves to open one induction, and the opposite eduction valve of the main engine at the proper time. 2d, In combination with the auxiliary cylinder and its pistons, applied and operating as described, to open the induction and eduction valves of the main engine, I claim the employment of the rock shaft and its toes, so applied in combination with the said eduction valves, that while they permit the said valves to be opened by the action of the steam on the pistons of the auxiliary cylinder, they keep the said valves open as long as may be desired.

341. MANUFACTURE OF WATER-PROOF HOSE; T. J. Mayall, Roxbury, Massachusetts.

Claim—My improvement in the manufacture of india rubber or gutta percha hose or tubing, which consists in impregnating the fibrous fabric which forms the bases thereof with protective or preservative substances, and subsequently coating with india rubber or gutta percha, and forming the same into hose or tubing.

342. STEELS; T. J. Mayall, Roxbury, Massachusetts.

Claim—A "steel" or implement for sharpening table-knives, &c., formed of india rubber or gutta percha, with which emery, sand, or other suitably gritty substances, are incorporated.

343. MANUFACTURE OF PACKING AND TUBING; T. J. Mayall, Roxbury, Massachusetts.

Claim—My new method of forming packing hose or tubing, and other similar articles, the same consisting in rolling or wrapping the fabric to be used around the core or mandrel, by rolling or passing said core or mandrel and the fabric or wrapper together between two surfaces, one of which exerts a self-adjusting yielding pressure upon the article to be formed, while the other surface has the necessary motion imparted to it, to roll or wind the fabric used around the cord or mandrel.

344. STEAM PLOUGHS; A. E. and S. N. McGaughey, Wastedo, Minnesota.

Claim—1st, The ploughs, attached to radial arms or oscillating shafts, and arranged with the pinions, racks, ratchet toothed hubs, and stop-rods, to operate as set forth. 2d, In connexion with the ploughs, arranged and operated as described, the rakes or harrows attached to the bars, for the purpose specified.

345. MEANS FOR CLIMBING TELEGRAPH POLES; J. H. McNeely, Indianapolis, Indiana.

Claim—The combination and arrangement of the hooks with the loops and set-screw, constructed as set forth.

346. CUT-OFF APPARATUS FOR STEAM ENGINES; Reuben Miller, Pittsburgh, Pennsylvania.

Claim—The employment, in combination with the tappets for opening the valve, to effect induction of steam, of the collars attached to the same valve rod, and the tappet levers with independent arms, said collars and tappet levers being applied and operating to effect the cutting off the steam at such point in the stroke of the piston, as may be desired.

347. RAILROAD CARS; John Miner and Silas Merrick, New Brighton, Pennsylvania.

Claim—Inserting strips of wood between the angle iron which forms the framework of the car, in combination with panel plates formed of a single piece of iron struck up, whether plain or ornamented. Also, constructing the ribs and framework of the car of two strips of L iron, with a bar of wood interposed, when these irons and the wood are united by rivets.

348. GRAIN SEPARATORS; J. R. Moffitt, Piqua, Ohio.

Claim—In combination with a reversible spout adapted to discharge grain at either end of a separating machine, the screen, placed within or above the said spout, and operated by the motion of the shoe, for the purpose of screening grain after the action of the winnowing apparatus.

349. CAR TRUCKS; F. L. Palmer, Knoxville, Tennessee.

Claim—The arrangement and combination of the bars, as set forth.

350. PAPER FILES; J. J. Parker, Marietta, Ohio.

Claim—The combination with the hinged book-back of bars, springs, and rods, arranged in the manner described.

351. MANUFACTURE OF HOLLOW MOULDED RUBBER GOODS; Dubois D. Parmelee, Salem, Assignor to John A. Greene, Beverly, Massachusetts.

Claim—The method described of shaping the said articles in moulds preparatory to their being vulcanized or hermized, that is, treated in the cold way by any known process, by applying heat to bags made of india rubber, its equivalent, or their compound, free from sulphur and inflated with air, so as to snugly fit the moulds, in the manner set forth.

352. TWINE SPOOLS; Francis A. Parmelee, New Haven, Connecticut.

Claim—The combination of the double spool with the spindle, as described.

353. COTTON-PICKER'S WALLETS; G. H. Peabody, Columbus, Georgia.

Claim—Applying a sponge, or other equivalent device, to a cotton-picker's wallet, for the purpose of enabling the picker to readily moisten his fingers, and thus facilitate his work.

354. PLOUGHS; Simeon F. Peck, Pennfield, Georgia.

Claim—The manner of attaching the share to the foot-bar, to wit: having the back part of the share notched and fitted in a rebate in the foot-bar, and receiving the shoulder formed by the rebate, while the ends of the share fit underneath the projections, and the lever is pressed on the outer side of the share by means of the wedge.

355. PROPELLER AND PADDLE-WHEEL SHAFT; William Peters, Baltimore, Maryland.

Claim—A propeller or paddle-wheel shaft. constructed as set forth.

356. WHIFFLETREE HOOKS; S. M. Perkins, Albany, Illinois.

Claim—1st, The combination of the stud with a revolving spring button, arranged as described. 2d, In combination with a revolving spring button, I claim a stationary stop, so arranged as to prevent the eye of the trace in all positions from passing over the buttons. 3d, The combination of the spiral spring, the projecting stud, and the inner stop, arranged as described. 4th, Constructing the button with the hooded end, as described.

357. CHAIN CABLE STOPPER; Charles Perley, City of New York.

Claim—The bridge over the chain, in combination with the cable-stopper, for the purpose of forcing the chain into said stopper, in the manner specified.

358. HORSE RAKES; Gideon Pierce, Ercildown, Pennsylvania.

Claim—The arrangement of the cog-wheel, rack, lever, frame, bar, standard, and teeth, as set forth.

359. HORSE HAY RAKES; Matthias Reaser, Reading, Pennsylvania.

Claim—The combination of the rock shafts, clearers, teeth, brace guides, spring bar, pins, and springs, with the draft-bar, arranged in the manner described.

360. LAMPS; Charles W. Richter, Madison, Georgia.

Claim—The use of the wick-adjuster, formed of the bar, with a toothed plate at its inner end, and so arranged as to have a certain degree of longitudinal adjustment in relation with the wick.

[This invention relates to an improvement in that class of lamps which are designed for burning those hydro-carbons that volatilize and glassify at a low temperature, such, for instance, as a combination of turpentine and alcohol, generally known as "burning fluid," the light or spirituous coal oils, &c.]

361. CATCH-BOLT; William Salisbury Wheeling, Virginia.

Claim—The use of the lever, combined and arranged with the catch-bolt, to operate as set forth.

362. CULTIVATOR TEETH; Henry Sanders, Utica, New York.

Claim—The flanches, a a, and semicircular projection on the tooth, and the flanches, c c, and pin on the chair, arranged as described.

363. COOKING STOVES; Samuel Smith, Philadelphia, Pennsylvania.

Claim—1st, The grate, having hollow bars communicating with each other, and arranged in respect to the hollow back and its zigzag passages, as set forth. 2d, The plates of the grate, arranged so as to serve the double purpose of connecting the bars of the grate together, and forming a chamber for heating the air preparatory to the same being discharged in jets into the front of the fire.

364. WATER-HEATER FOR STEAM ENGINES; James Speers, West Manchester, Pennsylvania.

Claim—1st, The arrangement of the float, lever, valve, partition, and pipes. b c and x, for the purpose of constructing water-heaters for supplying the force pumps of steam engines with heated water. 2d, The use of the branch pipe, x, in connexion with pipe, c, and valve.

365. PIANO-FORTES; Henry Steinway, Jr., City of New York.

Claim—The employment, in combination with the agraffa, of the projection, on the underside of the plate, lapping over and abutting against the edge of the turning block.

366. VALVE GEAR FOR STEAM ENGINES; David Stoddard, San Francisco, California.

Claim—The use of the fixed cam, in combination with the adjustable cam and the rocking bar, which is connected to the cam rod, and also connected to, and operated by, the cam yokes.

367. SHINGLE MACHINES; J. E. Sturdy, Augusta, Maine.

Claim—The use, in connexion with the shingle-sawing machine described, of the guides attached to the bolt carriage, and actuated alternately to perform their proper function to the planer.

368. RAILROAD CAR COUPLINGS; Joseph R. Swift, New Orleans, Louisiana.

Claim—The combination of the peculiarly constructed draw head with the peculiarly constructed elbow-shaped gravitating lever hook.

369. METAL STRINGS FOR PIANOS, &c.; J. B. Thompson, Philadelphia, Pennsylvania.

Claim—The employment, for the strings of piano-fortes, and other musical instruments, of hardened and tempered steel wire.

370. APPARATUS FOR ELEVATING WIRE; S. H. Swift, Morrisville, Vermont.

Claim—The bucket, curved at the rear, in combination with the trunnions, band, notched flanched wheel, roller, and frame, constructed in the manner set forth.

371. COMPOSITION FOR MAKING SOAP; George W. Tolhurst, Liverpool, Ohio.

Claim—A soap compound, prepared of the ingredients proportioned in the quantities hereafter mentioned, viz: five ounces common bar soap, four ounces sal soda, half ounce borax, half drachm of sugar, burned, and one teaspoonful of linseed oil; add as much rain water as to make a soap of suitable consistency; after it is boiled, it is ready for use.

372. RAILROAD CAR BRAKES; Alfred F. Toulmir, Ellicott's Mills, Maryland.

Claim—The mode described of simultaneously applying or putting down brakes by means of the brake cord, the box spring, the crank lever, the trigger, the cross-piece, the slide, and the swivel bar, with its springs, arranged as described. Also, the mode described of instantaneously freeing, relieving, or raising the brakes, and of keeping them free when raised, until the conductor, engineer, or brakesman shall desire to apply them, by means of the forward or tractive movement of the train, in combination with the slide, the cross-piece, and the trigger, with its shoulder.

373. STOVES; John G. Treadwell, Albany, New York.

Claim—The arrangement of the stove, flue, B, door. flue, D, and smoke-pipe, when the flue, B, is secured to, or made a part of, the underside or bottom of the stove.

374. COMPOSITION FOR SOLES AND HEELS OF SHOES AND BOOTS, VENEERS, PACKING, AND OTHER PURPOSES; Henry George Tyer, Andover, Massachusetts.

Claim—A composition made of vulcanized india rubber, leather, and gutta percha, in the proportions and manner set forth.

375. LAMPS; I. T. Vankirk, Frankfort, Pennsylvania, and Wm. M. Fulton, Granberry, New York.

Claim—The spindle with its cog-wheels, the said spindle being confined to its place by, and acted upon by a spring attached to the wick tube, and arranged in respect to the latter, as set forth.

376. GRAIN SEPARATORS; D. S. Wagener, Penn Yan, New York.

Claim—The case, with its flanches or divisions, surrounding distributor or sheath, for distributing the grain in a circular form within said case, and separating the impurities from the grain at said point by means of a suction and blast fans, or by a suction or blast fan, operating as described.

377. ROCKING CHAIR; John H. Wells, Brooklyn, New York.

Claim—The arrangement described of the legs, the hinge joint connecting the seat with the underwork and the springs.

378. MACHINES FOR CLEANING ANIMALS; Calvin D. Wheeler, City of New York.

Claim—Arranging and combining with a portable case or frame, a rotating comb and brush.

379. CANAL LOCKS; C. W. Williams, Port Jervis, New York.

Claim—1st, The arrangement of the sliding shaft, gearing, sliding rack, rods, wickets, and gate, applied to a canal lock. 2d, The employment of guard-strip applied to the gate, and arranged as set forth.

380. MACHINE FOR DRAWING BOLTS; Seth Wilmarth, Charlestown, Massachusetts.

Claim—The combination and arrangement of the several parts specified.

381. GRAIN SEPARATORS; William Wilmington, Toledo, Ohio.

Claim—1st, The combination of the endless belt, the dividing board, and the rotary reciprocating bars, the belt being separated from the bars by means of the board, used for delivering the straw and unseparated grain to the bars and its turning point. 2d, The combination of the teeth on the underside and end of the bars with the fingers or comb.

382. MACHINE FOR SHAVING BARK; Martin Winger, Lancaster County, Pennsylvania.

Claim—The combination of the convex traveling bed with the rotary knives and pressure rollers.

383. MOVING LOCOMOTIVE ENGINES BY HAND POWER; John E. Wootten, Philadelphia, Pennsylvania.

Claim—The application of the hydraulic piston to the purpose of propelling a locomotive engine or railroad car upon the track, by its direct action upon the periphery of the wheel, combined with the peculiar arrangement of the plunger in reference to the piston, whereby the latter is caused to advance and recede in concert with the plunger by the aid of atmospheric pressure, and without the intervention of valves.

384. BLIND-FASTENER; Oscar M. Andrews, Assignor to A. K. Seymour, Hecla Works, New York.

Claim—The arrangement on the side of the frame of a shutter or blind, and a rotary wedge-shaped cam, in combination with a hook, fastened in the manner specified.

385. CAN BOTTOMS FOR ROVING; George Bradley, Assignor to Jacob S. Rodgers, Paterson, New Jersey.

Claim—So mounting two or more can bottoms, that the filled can may be removed from under the coiler, and an empty one substituted in its place, by means, simply, of a partial rotation of the frame.

386. MOULDING FOR METAL CASTING; John P. Broadmeadow, Assignor to self and Albert Eames, Bridgeport, Connecticut.

Claim—The combined use of a half flask of a sufficient size to hold the quantity of loose sand required to form a half mould, and of a follow board, small enough to enter the said half flask and act as a piston to compress the sand therein, when pressure is applied. Also, the combined use of a half flask, as above described, and of a strike whose profile corresponds in form with the transverse section or profile of the pattern. Also, the combined use of a half flask, as above described, constituting the cope of a ribbed cope plate fitted to enter therein, and of sustaining pins in the said cope. Also, the combined use of the aforesaid cope plate, of a button plate fitted to enter the drag of the flasks, and of clamps. Also, combining the sprue pattern with the follow board, when this combination is used in connexion with a match-board having an opening to permit the descent of the lower end of the sprue pattern. Also, the combination of projections or indentations, or both, with the follow board, in contradistinction to constructing the flasks with projections and indentations.

387. HOLDING KNIFE-HANDLES FOR SOLDERING; Almon Cooley, Assignor to E. W. Sperry, J. H. Ashmead, E. Hurlbut, and Henry E. Robbins, Hartford, Connecticut.

Claim—The described device for holding knife-blades, handles, &c., for soldering together, the rods, cap, bar, and springs, operating in the manner set forth.

388. HOLDING KNIFE-HANDLES FOR SOLDERING; Almon Cooley, Assignor to E. W. Sperry, J. H. Ashmead, E. Hurlbut, and Henry E. Robbins, Hartford, Connecticut.

Claim—The device for securing or holding handles (formed of two parts,) for soldering; the adjustable yielding clamps or brackets, described; the combination of the yielding clamps or brackets with a turn-table, in the manner described.

389. WASHING MACHINE; Thomas Harvey, Assignor to self and David Kramer, Wooster, Ohio.

Claim—The combination of the two vertical movable plates with the inclined planes, and the fixed, perforated, corrugated partition, arranged as described.

390. PANS FOR EVAPORATING SUGAR JUICE; Wheeler Hedges, Assignor to self and P. W. Gates, Chicago, Ill.

Claim—1st, The arrangement of the pipes, E E, with the pipe, F, in pan, so that the application of steam to the pipes, E E, will cause the greatest ebullition, and the foam to raise highest longitudinally in the middle of the pan, for the purpose of causing all impurities to be deposited upon the flaring sides of the pan. 2d, The construction and application of a defecator, in combination with the evaporator. 4th, The stop-boards, in combination with the evaporator, as described.

391. RETORTS FOR DISTILLING COAL OIL; Mathew Hodkinson, Assignor to Mathew Hodkinson, Jr., Pittsburgh, Pennsylvania.

Claim—The stationary retort with a shaft armed with knives, whose edges are at right angles with the shaft passing through it, by which, when motion is given to the shaft, the coal is broken and pulverized more effectually and more economically than by any other method.

392. NURSING BOTTLES; Francis J. La Forme, Boston, Massachusetts.

Claim—The improved nurse bottle, or one having an elastic tube, applied thereto in the manner set forth.

393. MACHINE FOR MANUFACTURING RUCHES; Daniel Penman and Elisha Fitzgerald, Assignors to William C. Walker and M. Penman, City of New York.

Claim—The pressing bar, attached to the shaft by the arms (said arms having a crank) at its end, in combination with the adjustable gauge bar, hook rods, and treadles.

394. BOOT AND SHOE TIP; Newman Silverthorn, Prescott, Wisconsin, Assignor to James M. Allen, Fredericktown, Ohio.

Claim—A boot or shoe tip, made of any of the known preparations of india rubber or gutta percha, and to be applied to the boot or shoe, in the manner described.

EXTENSIONS.

1. VAULT COVERS; Thaddeus Hyatt, City of New York; patented Nov. 12, 1845; re-issued April 3, 1855; extended Nov. 5, 1859.

Claim—Making them of a metallic grating or perforated metallic plate, with the apertures so small that persons or bodies passing over or falling on them may be entirely sustained by the metal; but this I only claim when the apertures are protected by glass. Also, in combination with the grating or perforated cover and glass fitted thereto, the knobs or protuberances on the upper surface of the grating or perforated plate, for preventing the abrasion or scratching of the glass.

2. FORGES; Christian V. Queen, Peekskill, New York; patented Nov. 18, 1845; extended Nov. 22, 1859.

Claim—The combination of the curved sliding shutters for enclosing the space over the fire, and the device for admitting a draft of air to keep up the combustion during the intervals in which the bellows are not employed.

3. PLANING MACHINES; Joseph E. Anderson, Boston, Mass.; patented Nov. 21, 1845; extended Nov. 22, 1859.

Claim—The manner shown of forming, arranging, and combining with the revolving cutter wheel, the revolving platform and the endless aprons between which the board to be planed is to be passed, by means of which arrangement and combination it is firmly held along the whole length of such apron, and carried regularly forward without deviation.

4. MAGNETIC WATER GAUGE FOR BOILERS; George Faber, Canton, Ohio; patented Nov. 26, 1845; extended Nov. 22, 1859.

Claim—The method described of indicating the rise and fall of water in a steam boiler or generator by means of an indicator outside thereof, actuated by a magnet connected with a float or any other body within the boiler that rises and falls with the water, and connected with the magnet.

ADDITIONAL IMPROVEMENTS.

1. GOLD-WASHER; Mortimer Nelson, City of New York; patented Oct. 4, 1859; additional dated Nov. 8, 1859.

Claim—1st, Imparting to the shaft and the series of pans thereon, an intermittent or oscillating movement; and in combination with the shaft and pans having the intermittent or oscillating movement set forth, I claim the cam and ball to give the vertical or jigging movement. 2d, The conical hoods or funnels in combination with the pans.

2. APPARATUS FOR WATERING AND SWEEPING RAILROADS; Wm. C. Allison, Assignor to self and John Murphy, Philadelphia, Pennsylvania; patented December 18, 1849; additional dated Nov. 15, 1859.

Claim—Combining a fire-place and flues, or their equivalent heating apparatus, with the water tank, for the purpose specified.

3. NAVAL ARCHITECTURE; Benjamin F. Wells, Georgetown, D. C.; patented October 18, 1859; additional dated Nov. 22, 1859.

Claim—Making the lines of every section of a vessel, from the keel to the water-line, arcs of circles, when said arcs have separate and independent centres determined in the manner described.

4. STRAW CUTTERS; W.W. Hollman, Eddyville, Ky.; patented March 30, 1858; additional dated Nov. 29, 1859.

Claim—The combination and arrangement of the devices for operating the knife and feeding-box as described.

RE-ISSUES.

1. MACHINES FOR CLEANING GRAIN; William M. Griffith & Co., Assignees of William H. Orr, Martin's Ferry, Ohio; patented July 13, 1859; re-issued November 1, 1859.

Claim—The arrangement and application of the stirrer in the described relation to the riddle or shoe of a grain separating machine, operating in the manner set forth.

2. REVOLVING FIRE ARMS; E. K. Root, Hartford, Conn.; patented Dec. 25, 1855; re-issued Nov. 1, 1859.

Claim—Combining the driving-pin that works in the grooves to rotate and hold the breech in line with a slide below adapted to the reception of and to be operated by the trigger-finger, and acting on the lock on the end of the back motion, to liberate the cock or hammer and discharge the load. Also, combining the plunger with the many-chambered rotating breech pistol or other fire arm, by means of a lever with a cogged sector engaging the cogs of a straight rack, substantially as and for the purpose specified.

3. STRAW-CUTTERS; De Witt C. Cummings, Fulton, New York; patented Aug. 7, 1855; re-issued Nov. 8, 1859.

Claim—1st, Operating the adjustable lower feed-roller by means of a spur-wheel hung in a vibrating frame or yoke, the axis of which is connected with the said roller by means of an universal coupling, when said roller is supported on spring bearings independent of each other. 2d, The employment of a cylinder provided with a knife or knives which have an upward cylindrical cut arranged with two independent feed-rollers, the lower one of which being supported on a spring or springs in such a manner that it can be adjusted to act with greater or less pressure on the material to be cut.

4. PUMPS; Wm. M. Henderson, Baltimore, Md.; patented Oct. 4, 1859; re-issued Nov. 8, 1859.

Claim—The two ball valve cages with the suction valves in their interior, attached to the extremities of a central perforated tube or its equivalent, in combination with the water ways and discharge valve or valves; the water entering between the plunger-valves and alternately discharged from the ends of the pump barrel in direction of the stroke.

5. Lock and Detector; John H. Lyon, City of New York; patented Sept. 13, 1859, re-issued Nov. 8, 1859.

Claim—Combining with a padlock, or any lock provided with a shackle, a lead or soft metal tube or seal, so arranged as to be temporarily secured thereto and admitting of being released only by the removal or breaking of said tube or seal, which thereby serves as a detector.

6. Rim for Lockets; Charles G. Bloomer, Wickford, Rhode Island; patented April 28, 1857; re-issued Nov. 15, 1859.

Claim—A rim for lockets and similar metallic cases, formed of sheet metal, in such manner that the face of the field-piece within the case and the exterior surface of the rim, are both formed from the same side or surface of the original sheet metal, and that the field piece and rim are of one piece of metal.

7. Mode of Constructing Lockets; Charles G. Bloomer, Wickford, Rhode Island; patented April 28, 1857; re-issued November 15, 1859.

Claim—The method of imparting the finished shape to case rims of sheet or thin metal, in which the external ring and field-piece are one piece of metal, by means of dies.

8. Machine for Wetting and Cutting Paper for Printing Presses; Moses S. Beach, Brooklyn, New York; patented August 25, 1857; re-issued November 15, 1859.

Claim—1st, The combination with the printing machine of the mechanism described, so arranged that the paper, as it passes along from the reel to be printed upon, shall be dampened. 2d, The combination, with the cylinders, C D, of the adjustable rollers, E F, to supply the moisture for the paper, and also to regulate the quantity of that moisture. 3d. The combination with the printing machine of the moisture vessels. 4th, The combination of the cutting knife with the dampening roll-cylinder. 5th. Simultaneously wetting or moistening both sides of the paper, in the manner described. 6th. Leaving the paper dry at the point or line of cutting. 7th, The employment of a spring pressure to project the knife, in the manner described. 8th, Retiring the knife within circumference of the cylinder, by means of the cams. 9th, Catching the knife, when retired within the circumference of the cylinder, C, retaining it while so retired, and releasing for the operation of cutting by means of the catches, the springs, and the tripping pins. 10th, The employment of cylinders, C D, to draw the paper from the reel, to be afterwards cut into sheets, and fed into the printing machine. 11th, Breaking or tearing asunder any fibres of paper left uncut by the knife, by the grasp of the cylinder, M, and roller, Q. 12th Giving the conducting or guide tapes a speed greater than that of the paper. 13th, The combination of the feeding mechanism, cutting apparatus, and the printing machine, in the said combination for feeding the paper from a roll to a printing machine, and cutting, or partially cutting, it into sheets as it passes along to be printed.

9. Bending Wood; Thomas Blanchard, Boston, Massachusetts; patented December 18, 1849; re-issued Nov. 15, 1859.

Claim—My improved method of bending wood, as described.

10. Apparatus for Cooling Liquids; Berresford Maria King, executrix of Valentine Hall, deceased, City of New York; patented Sept. 20, 1859; re-issued Nov. 22, 1859.

Claim—1st, The employment or use of one or more receivers, with or without the pump, placed on a tank containing ice water or water at a low temperature, and connected together and to the liquid supply pipe as set forth. 2d, The employment or use of one or more receivers, placed within a tank, and connected with the barrel or cask by means of a siphon, and with a pump within or at the outer side of the tank, for the purposes set forth. 3d, The combining of a pump with one or more receivers connected together and made to communicate with each other by siphons, when said parts are submerged within a tank, and made to communicate with the barrel or cask by means of a siphon extending over the top of the tank.

11. Machines for Ploughing; Jos. W. Fawkes, Christiana, Pennsylvania; patented Jan. 26, 1858; re-issued November 22, 1859.

Claim—1st, The employment, in combination with the locomotive, of a bilge-shaped driving-wheel. 2d, I do not claim broadly the invention of movable spurs, but I claim the combination of the sliding spurs with the bilge-shaped driving-wheel, as described. 3d, The arrangement of the adjustable frame, ploughs, gauge-wheel, driving-wheel, engine, boiler, and guiding-wheels.

12. Running Gear of Locomotive Engines; Septimus Norris, Philadelphia, Pa.; patented Sept. 26, 1854; re-issued March 2, 1858; re-re-issued November 22, 1859.

Claim—The combination of a free vibrating truck, with six or more driving-wheels, when the front pair of drivers is placed in advance of the centre of gravity of the entire engine, as set forth.

13. Steam Boilers; William Oldham, Buffalo, New York; patented June 7, 1859; re-issued Nov. 22, 1859.

Claim—1st. The central water space in the combustion chamber, arranged in relation to the annular water space and to the tubes or their respective equivalents, as set forth. 2d, Placing the annular sheet, and horizontal plate (which with the jacket form the smoke-pipe,) outside of the water space, to allow the sediment to be conveniently removed from the water space, in communication with the described arrangement of the return tubes.

14. Making Brass Kettles; O. W. Minard, Waterbury, Conn.; patented April 15, 1856; re-issued Nov. 29, 1859.

Claim—The employment of two rotating rollers, for griping, turning, and rolling the disc of metal, in combination with the clamps or holders for holding the disc of metal at any desired angle with the axis of the rollers. Also, the concave and convex clamping plates in combination with the rollers or any equivalent mode of rolling the metal. Also, in combination with the rollers for rolling the disc of metal, the supporting rest for supporting the metal beyond the point of action of the griping rollers.

15. Reaping and Mowing Machines; Jeremiah W. Mulley, Amsterdam, New York; patented Feb. 10, 1857; re-issued Nov. 29, 1859.

Claim—So constructing and arranging the platform of a reaper as that it, or a portion of it, may be made to form a track-clearer when it is desired to convert the machine into a mower.

16. Reaping and Mowing Machines; Jeremiah W. Mulley, Amsterdam, New York; patented Feb. 10, 1857; re-issued Nov. 22, 1859.

Claim—The hollow reel-shaft made of sheet metal or its equivalent, formed with boxes or bearings at or near each end, and made to revolve on an arm supported at one end only.

17. Reaping and Mowing Machines; Jeremiah W. Mulley, Amsterdam, New York; patented Feb. 10, 1857; re-issued Nov. 29, 1859.

Claim—1st, The manner described of securing the detachable cutters or blades to or in their place on the cutter-bar, and relatively to each other, by means of central holding screws in combination with pins

or studs on the bar, to fit the recesses in the adjoining sides of the blades. 2d, Providing the fingers with the laterally projecting lips in front and rear of the slot in which the cutter-bar plays. 3d, The finger-bar arched as described in combination with the fingers made with a swell or convex projection in their rear.

DESIGNS.

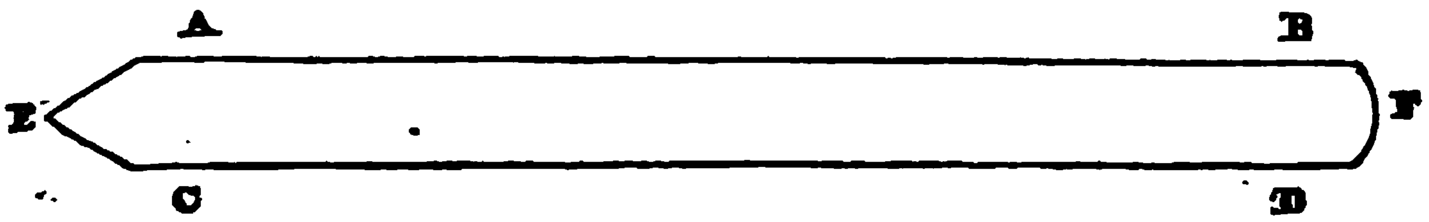
1. CLOCK CASES; Charles T. Foot, Bristol, Conn.; dated November 1, 1859.
2. TRADE MARK; Thomas and Samuel Hardgrove, Richmond, Va.; dated November 1, 1859.
3. BASE FOR CASTERS; Allen Leonard, Hartford, Conn.; dated November 1, 1859.
4. CASTER HANDLES; Allen Leonard, Hartford, Conn.; dated November 1, 1859.
5. FORK OR SPOON HANDLES; William H. Lewis, Glastenbury, Conn.; dated November 1, 1859.
6. STOVES; Garretson Smith and Henry Brown, assignors to Cox, Whitman & Cox, Philadelphia, Pa.; dated November 1, 1859.
7. CARRIAGE BODIES; Harrison Grosh, Litis, Warwick Township, Pennsylvania; dated Nov. 15, 1859.
8. CARPET PATTERNS; Elemir J. Ney, assignor to the Lowell Manufacturing Company, Lowell, Mass.; dated November 22, 1859. (2 cases.)
9. FLOOR CLOTHS; J. B. Virolet, assignor to John W. Hoyt, City of New York; dated Nov. 29, 1859.

MECHANICS, PHYSICS, AND CHEMISTRY.

*Method of obviating the effect produced by Currents in Telegraph Wires induced by Terrestrial Currents.** By H. W. ELPHINSTONE.

A B, C D, are two similar telegraph wires, parallel to each other, separated by a small space; at F they communicate with the two ends of the helix of a galvanometer F; at E there is a commutator, by means of which the two telegraph wires can be put in contact with each other, or be joined respectively to the poles of a battery.

Suppose the two wires to be in contact with each other; let there be a terrestrial current which induces a current in A B sufficient to cause a deviation d in the galvanometer at F, the same current will induce a current in C D which will produce a deviation d' in the galvanometer at F. But since these two currents enter the helix at its opposite ends, d and d' have opposite signs; the total deviation is $d—d'$, a quantity that will generally be small.



Now, by means of the commutator, place the battery in circuit, and let the deviation produced by the battery be D; the induced currents remain the same as before; the total deviation will be $D + d — d' = D$ nearly.

If in practice $d—d'$ could be rendered so small as not to be comparable with D, there would be no need of keeping the ends of the telegraph wires in contact when the battery is out of circuit; it would be sufficient to insulate them, so as to prevent any extraneous current passing by accident through the wires. If $d—d'$ could not be rendered small enough to be neglected, it would, at all events, be smaller than d, which is the deviation under the present system. And it would not, I think, be impossible to distinguish the battery signal by a previous arrangement having been made by the operators to send battery signals at constant intervals of time, every 10 seconds for instance, reading off immediately before and after the signal was transmitted.

* From the Lond. Ed. and Dub. Phil. Mag., Nov., 1859.

*On Platinized Graphite Batteries.** By C. V. WALKER, Esq., F.R.S., F.R.A.S, &c. Received January 4th, 1859.

In a short note communicated to the Royal Society on March 9th, 1857, and which was read on March 19th, reference was made to the voltaic combination that I had adopted for certain telegraphic purposes; namely, zinc-graphite. Graphite in its crude state had for some years been of great service to me, especially for batteries whose resting time is great in proportion to their working time. Since the date of that notice, I have considerably increased the value of graphite for electrical purposes by platinizing it according to the process first described by Mr. Smee, whose platinized silver battery has been long known and much used. The material to which I refer by the term "Graphite," is the crust or corrosion that is collected from the interior of iron gas retorts that have been long in use.

My first crude graphite battery of twelve pairs of plates was set up on April 5th, 1849, for working the telegraph from my residence at Tonbridge to the Telegraph Office, about a mile distant. It was charged with sand saturated with diluted acid; and had not been dismounted in March, 1851, when I changed my abode. During the interval, the sand was from time to time moistened with acid water or water only. The plates in this case had been roughly chipped out and rubbed on stone into something like shape. In the mean time I had some sets of plates cut at the Locomotive Works, Ashford, and was thus enabled to obtain further results. I forwarded a graphite battery to the Great Exhibition in 1851, for which a prize medal was awarded. The introduction of graphite into any thing like general use was for a long period no easy matter, on account of the difficulty of finding any one who would undertake to cut it into plates, its hardness destroying the tools; and the then limited demand did not encourage any one to construct special machinery for the purpose. My wants at length reached the ear of Mr. J. Robinson, of Everton, Liverpool, who took the matter thoroughly in hand, and has succeeded perfectly in cutting plates into any form and to comparatively any size, at a very moderate cost, for which I am much indebted to him. I have before me plates 12 inches $\times$ 10 inches, of smooth texture and uniform thickness, and have seen some of double that size.

The plates in common use for bell signals are $7\frac{1}{2}$ inches $\times$ 3 inches and $\frac{3}{8}$ inch thick, of which about 2000 are in daily use on the South-Eastern Railway, and the greater portion of these are now platinized. The plates are delivered to me in their crude state, that is to say, they are merely cut into form. Immediately on arrival they are placed in a stone pan, and covered with a mixture of 1 sulphuric acid + 4 water, in which they are allowed to remain for three or four days or more. They are taken out as required, and are washed under a tap of running water; this operation dissolves out any foreign matter that might be pernicious in a voltaic combination wherein sulphuric acid was employed; they are then partially dried. A hole for a rivet is next drilled in the middle, near the top of each plate—a belt of var-

* From the Proceedings of the Royal Society, No. 34.

nish one inch wide is applied to the top on both sides of each plate—a blank one inch square, having the rivet hole for its centre, being left unvarnished on each side—electrotype copper is then deposited on the blank square in the usual way. The deposited metal is then tinned, no part of the copper being left bare; a connecting slip of copper, 6 inches × 1 inch, is prepared and also entirely tinned; this is riveted to the graphite plate with a copper rivet, also tinned. The soldering iron is now applied, and a little solder run in between the two surfaces. By thus protecting all the exposed copper with tin, the formation of sulphate of copper and its attendant inconveniences are prevented. The plate is now platinized.

A mixture of 1 sulphuric acid + 10 water is placed in a vertical glass cell, to this are added a few crystals of chloride of platinum till the solution presents a faint straw color. The battery power employed for platinizing is three cells of platinized graphite and zinc. The positive electrode is platinum or graphite itself, and is presented to both sides of the plate that is to be platinized. The action is allowed to go on for about twenty minutes. Each finished plate is tested as to its power of liberating the hydrogen of electrolysis, by placing it in acid water in contact with an amalgamated zinc plate.

I have drawn out the above description in the presence of our assistant, who attends to this department of the telegraph establishment, in order to be correct in the small details.

The battery-cells for the plates above described are quart jars of stone-ware that resists acid. The exciting solution is 1 sulphuric acid +8 to 12 water. Zinc plates are riveted to the other end of the copper connecting slip, also with tin rivets. The zinc is strongly amalgamated. It is dipped in a vessel containing 1 sulphuric acid +4 water, and after a few seconds, more or less, is withdrawn and thrust in its then condition into a trough of mercury, and set aside to drain. On the following day it is treated in a similar manner. When the batteries are being put together, and before the zincs are placed in the jars, the foot of each is placed in a trough or slipper of gutta percha, 3 inches by ½ inch, containing about a couple of ounces of mercury. A battery thus carefully prepared will stand for an indefinitely long period with little perceptible waste, and be ready for use at all times. Under ordinary circumstances it is not necessary to dismount the batteries employed for telegraph signaling more than once a year. Mercury is added during the interval, and the jars are filled up as occasion requires. The greater portion of the mercury is recovered: when old plates come home, a considerable quantity of rich amalgam is scraped from the plates; this is placed in jars of acid water, and a few pieces of graphite are thrown in; the electro-chemical action makes the amalgam poorer of zinc, and mercury is easily expressed. By continuing the operation, more mercury, to the amount in all of nearly three-fourths, is recovered.

As an illustration of the economic importance of this material in applied science, I am informed that the silver plates of the batteries constructed for the Atlantic Telegraph cost £2520 or more. On my having directed the attention of the Company to graphite as a substi-

tute for silver, a set of plates were ordered, equal in number and size, which were supplied (furnished with electrotype copper and connecting wires) for £216.

TABLE I.—*Electro-magnet; 10 yards No. 16 wire.*

12 cells in series.				12 cells in double series of 2 sixes.			
Resistance.	Silver.	Graphite.	Graphite.	Resistance.	Silver.	Graphite.	Graphite.
yds.	lbs.	lbs.	lbs.	yds.	lbs.	lbs.	lbs.
10	14·75	14·00	15·00	10	22·50	20·50	20·00
147	10·00	12·50	9·00	147	14·00	10·00	9·00
284	7·00	9·00	8·00	284	8 25	7·00	7·00
421	6·00	7·00	6·00	421	5·00	5·00	4·00
558	5·00	5·00	4·00	558	3·25	3·00	2·50
695	4·50	3·00	3·00	695	2·00	2·25	1·50
832	3·00	2·50	2·50	832	2·00	1·50	1·25
6 cells in series.				6 cells in double series of 2 threes.			
10		12·25	10·00	10	14·00	14·00	14·00
147	9·00	6·25	7·00	147	4·00	4·00	5·00
284	5·00	5·00	4·00	284	2·50	2·25	2·50
421	3·50	4·00	2·50	421	2·00	1·75	2·00
558	2·25	2·00	2 00	558	1·50	1·25	1·00
695	2·00	1·50	1·00	695	1·00	1·00	1·00
832	1·50	1·25	0·75	832	0·75	0·75	0·75

TABLE II.—*Electro-magnet; 274 yards No. 16 wire. 12 cells in series.*

Resistance.	Silver.	Graphite.	Graphite.
yards.	pounds.	pounds.	pounds.
137×2	14·00	18·00	22·50
137 3	12·75	15·75	14·00
137 4	10·00	13·00	11·00
137 5	9·00	12·50	11·00
137 6	9·00	10·75	11·00
137 7	9·50	9·50	9·00
137 8	8·75	9·50	8 75
6 cells in series.			
137×2	9·75	12·75	11·00
137 3	8·00	10·75	10·00
137 4	7·25	10·00	9·50
137 5	7·75	9·00	9·00
137 6	7·00	8·00	9·00
137 7	6·75	9·00	8·75
137 8	7·00	8·75	8·00
6 cells in double series of 2 threes.			
137×2	8·75	10	11·00
137 3	7·25	9	9·00
137 4	6·00	9	9·00
137 5	7·75	8	7·00
137 6	4·25	6	5·00
137 7	4·00	6	4·75
137 8	4·25	5	6·00

The foregoing Tables illustrate the effective working powers of platinized graphite, as compared under like circumstances, with platinized silver, given in lifting powers in pounds. A third column is added, giving the results when table salt is dissolved in the water employed with the graphites.

In all the above experiments the cells were charged with 1 sulphuric acid + 13 water (salt water in the third column); and 13·5 square inches of surface were immersed. The silver-zinc pairs were 1 inch apart, the graphite-zinc, 2 inches. The lifting powers were not read off more closely than to quarter-pounds. The electro-magnet used in Table I. was a small horse-shoe containing about 10 yards of No. 16 wire; that used in Table II. was one of the electro-magnets used in the construction of the signal bells before described (*vide* Proc. Roy. Soc., vol. viii. p. 419), and containing 274 yards of No. 16 copper wire. The resistance added in each successive experiment was one bobbin of a similar electro-magnet or 137 yards of wire. The resistances in the Table include the resistance of the electro-magnet. The total resistances in Table II. are all multiples of the contents of a single bobbin or 137 yards. A glance from left to right on the same horizontal line shows the comparative value of each combination in the several experiments. One or two small irregularities in Table II. in the six-cell results, are doubtless due to the poles of the magnet not having been ground true.

With respect to durability, the graphite plates in use since 1850 are in as good condition as the new ones now in course of manufacture. Silver plates employed by us under like circumstances, commenced perishing after twelve months or more of use; they crumble away in great measure, they cut apart at the surface level, and they get eaten into holes throughout.

To Prof. J. C. Cresson, Pres. Franklin Institute.

DEAR SIR:—I enclose the within extract from the San Francisco "*Bulletin*" newspaper, of the 1st inst. The existence of a belt of ocean whose waters contain boracic acid in appreciable quantity, and extending along the entire coast of California, is an interesting fact to scientists—and I send the publication of the fact for any use you may please to make of it.

The analyses of Dr. Veatch on this subject, have been made most carefully, and are entitled to entire credit.

San Francisco, Cal., December 3, 1859. LEWIS BLANDING.

Boracic Acid in the Sea-water on the Coast of California.

The following interesting paper on boracic acid in the sea-water of the Pacific, on the coast of California, was read by Dr. John A. Veatch before the California Academy of Natural Sciences. The facts presented may lead to important results in various ways, and deserve attention from scientific men. The Doctor said:

The existence of boracic acid in the sea-water of our coast was

brought to my notice in July, 1857. I had, in the month of January of the previous year, discovered borate of soda and other borates in solution in the water of a mineral spring in Tehama county, near the upper end of the Sacramento valley. Prosecuting the research, I found traces of boracic acid—in the form of borates—in nearly all the mineral springs with which the State of California abounds. This was especially the case in the Coast mountains. Borate of soda was so abundant in one particular locality, that enormous crystals of that salt were formed at the bottom of a shallow lake, or rather marsh, one or two hundred acres in extent. The crystals were hexehedral with beveled or replaced edges, and truncated angles; attaining the size, in some cases, of four inches in length by two in diameter, forming splendid and attractive specimens. In the same neighborhood, a cluster of small thermal springs were observed holding free boracic acid in solution. A few hundred yards from these a great number of hot springs, of a temperature of 212° Fah., rose up through the fissures of a silicious rock. These springs held a considerable quantity of borax, as well as free boracic acid. Many other localities furnished similar indications, but in a less extensive form.

In progress of the examination I found that the common salt (chloride of sodium) exposed for sale in the San Francisco market, and which, it was understood, came from certain deposits of that article on the sea-margin in the southern part of the State, also furnished boracic acid. I was led to attribute it to the fact of mineral springs emptying into the lagoons furnishing the salt. It was, therefore, a matter of no small surprise, when on a visit to the localities, I found no trace of acid in any of the springs in the adjacent district. This led to an examination of the sea-water, and a detection of an appreciable quantity of boracic acid therein. It was at Santa Barbara where I first detected it, and subsequently at various points, from San Diego to the Straits of Fuca. It seems to be in the form of borate of soda, and perhaps of lime. The quantity diminishes towards the North. It is barely perceptible in specimens of water brought from beyond Oregon, and seems to reach its maximum near San Diego.

This peculiarity seems to extend no great distance seaward. Water taken thirty or forty miles west from San Francisco gave no trace of acid. In twelve specimens, taken at various points betwixt this port and the Sandwich Islands, furnished me by Mr. Gulich, of Honolulu, only that nearest our coast gave boracic acid. In ten specimens kindly furnished me by Dr. W. O. Ayres, taken up by Dr. J. D. B. Stillman, in a trip of one of the Pacific mail steamers from Panama to this place, no acid was observed south of the Cortez Shoals.

I have not as yet been able to obtain specimens of water south of San Diego, nearer the shore than the usual route of the mail steamers. Neither have I been able to test the breadth of this boracic acid belt any further than the fact above stated, of no acid being found at the distance of thirty or forty miles west from the Golden Gate. I think it probable that it is confined within the submarine ridge running parallel with the coast, the southern portion of which is indicated by

certain shoals and island groups. The source of the acid is undoubtedly volcanic, and the seat of the volcanic action is most likely to exist in this submerged mountain range. It strengthens the probability of the eruptive character of the Cortez Shoals.

I hope in future to be able to make more accurate and extended examinations, unless some one more capable of doing justice to the subject should take it in hand. With this view, I solicited the attention of Dr. J. S. Newberry to these facts, while he was in this city, on his way to join Lieut. Ives' Colorado Exploring Expedition, hoping he might think it worthy of investigation during his stay on this coast. With the same view, I now submit them to the Academy.

Proceedings of the British Association for the advancement of Science. 29th Annual Meeting, 1859.*

Section G.—*Mechanical Science.*

Friday.—"Report of the Patent Committee."—This Committee, which was appointed at Leeds, last year, states that it appears by the Annual Report of the Commissioners of Patents just issued, that above 3000 applications are made annually for patents; that of these 1000 are dropped at the first stage, leaving only 2000 to be completed as patents; that the £50 payment at the end of the third year, in order to keep the privilege on foot for seven years more, causes 1500 of the 2000 patents to drop at the end of the third year, leaving 500 only remaining, and that of this 500, the Commissioners of Patents estimate that in consequence of the required payment of £100 at the end of the seventh year, 100 only will survive to complete the term of fourteen years. The Committee's Report points out that the large estimated surplus, amounting to £100,000 annually, was properly suggested by the Commissioners as applicable to the building and maintaining suitable offices for the Commission, including a free library and a museum of inventions. The Committee recommends that, after carrying out these objects, the fees received from patentees should be reduced to an amount not more than sufficient to defray the expenses of the office; but that if such a course was not adopted, then that the sums received from inventors should be carried to an "Inventors' Fee Fund," to be applied for the benefit and promotion of science and industry.

"On Experiments to determine the Efficacy of continuous and self-acting Brakes for Railway Trains," by Mr. W. Fairbairn.†

"Description of Glasgow Waterworks," by Mr. J. F. Bateman.

"On a Safety-Cap for Mines," by Mr. R. Aytoun.

"On the Rivers 'Dee,' forming the Ports of Aberdeen and Chester," by Mr. J. Abernethy.

The Astronomer Royal, having been officially engaged in investigating the estuary of the Dee at Chester, said, that he thought that engineers were too often apt to forget that if that had a scour out that there was also a scour in, and that the weight of stone carried by a current varied as the sixth power of the velocity, and that the movement of the flow was more rapid than that of the ebb. He believed

* From the Lond. Athenæum, Oct. 1859. † See Jour. of the Franklin Institute, p. 12.

that, do what they could, the estuary of the Dee at Chester was doomed. Liverpool estuary was also filling up. He objected to the groynes which had been made.—Mr. G. Rennie remarked, that one-third of the area of the estuary had been destroyed, by embankments formed by proprietors of property on the sides.—Mr. J. F. Bateman said, that groyning in the Clyde had been beneficial, and the navigation of the Clyde had been improved to an extent which had no parallel.—Capt. Sir E. Belcher had had much experience in these matters, and he found that the flood-tide of salt water coming in lifted the fresh, and ripped up the bed of the river. He did not approve of straitening their courses.—Mr. Webster thought that straitening and deepening were most beneficial. It caused an anticipation of the time of high water, and there was a longer ebb aiding in this scour.—The Astronomer Royal approved of the restricting the water to a narrow channel, and he thought that the efficiency of the out-scouring was greatly due to the amount of fresh water coming down.

Saturday.—"On the Result of Boring for Water in the New Red Sandstone, near Shiffnal, in the County of Salop," by Mr. J. F. Bateman.—The supply of water to Wolverhampton being found insufficient, new works have been constructed by the author for bringing the water from the River Worth, nine miles from Wolverhampton and three from Shiffnal. The River Worth, at the place where the pumping-works are erected, is not more than forty or fifty feet above the Severn, which it joins at Bridgwater, eight or ten miles distant. It may therefore be considered as the bottom of a basin little above the level of the sea. From the character of the surrounding hills, and the inclination of the beds of New Red Sandstone, it appeared to the author of the paper likely that although the wells previously sunk on the high plateau of Wolverhampton had proved comparative failures, a considerable quantity of water might be found in the sandstone at the lower level, and that some might overflow, as an artesian well. A bore-well was accordingly commenced near Shiffnal, 12 inches in diameter, and continued for 70 feet, when it was diminished to 7 inches, and carried down to a total depth of 260 feet from the surface. Water was met with first at a depth of 22 feet, and from that time it rose with increasing supply to the surface, and flowed over as an artesian well, giving a supply in the end of 210,000 gallons daily. Throughout the whole depth of boring the work varied but little in character. It was nearly all hard rock, sometimes very hard, with occasional beds of soft stone. For the last 40 feet or so the soft beds were thicker; but otherwise there was little change from top to bottom. As the whole well is charged with water to the level of the river, which forms its natural outlet, and as the boring shows that the lower beds receive their supplies from distant sources, the supply may reasonably be expected to be inexhaustible within the limits of that which is due to the percolation of the rain upon the collecting area.

"On a Patent Chain Propeller," by Mr. W. Robertson.*

"On the Manœuvring of Screw Vessels," by Admiral Paris.—The author showed how vessels furnished with the screw-propeller could,

* This article will be published in our next number.

whether making way or not, be guided and manœuvred; and expressed his opinion that the Great Eastern, furnished, as she was, with paddles and screw, would be the most handy vessel ever yet built. The paper contained a vast amount of technical details, which could only be understood by nautical men.

Sir E. BELCHER bore testimony to the importance and value of the paper.

"On the True Action of what are called Heat Diffusers," by Mr. A. TAYLOR.

"On a Boat-Lowering Apparatus," by Mr. A. BATTEN.

"On a Mode of Suspending, Disconnecting, and Hoisting Boats attached to Sailing Ships and Steamers at Sea," by Mr. E. A. WOOD.

"On Smokeless Coal-burning Locomotive Engines," by Mr. D. K. CLARK.—This arrangement cannot be fully described without reference to diagrams; but it may be stated that a perfect combustion is obtained by means of several steam jets, which cause a strong blast of air to be brought in contact with the burning fuel.

In the discussion, it was stated that the arrangement was in successful use, and with economy in consumption of fuel.

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*Experiments on Cast Iron.**

A series of valuable experiments has recently been carried on under the superintendence of Col. F. Eardley-Wilmot, superintendent of the Royal Gun Factories at Woolwich, upon various British irons, with a view to determine the most suitable varieties for the manufacture of cast iron ordnance. The results of these experiments are printed in a tabular form in a parliamentary report lately issued. The tables occupy nearly the whole of a thick folio book, and show the strength of various specimens of iron supplied by the principal iron founders of the kingdom, when subjected to tensile, transverse, torsion, and crushing tests.

"The general results of a considerable number of such experiments are shown in the following table:—

	Specific gravity of 850 specimens.	Tensile of 850 specimens.	Transverse of 564 specimens.	Torsion of 276 specimens.	Crushing of 273 specimens.
Maximum,	7·340	34,279	11,321	9,773	140,056
Minimum,	6·822	9,417	2,586	3,705	44,563
	Of fifty-one samples.	Of fifty-one samples.	Of 53 samples.	Of fifty one samples.	Of fifty-one samples.
General Mean,	7·140	23,257	7,102	6,056	91,061

From the prefatory remarks to the tables we quote the following passages, which indicate some remarkable peculiarities in the condi-

* From the Lond. Civ. Eng. and Arch. Journal, Dec., 1859.

tion of the specimens of iron, and the effect which a slight change of circumstances in casting produced on the strength of the metal.

"The results already obtained by various experiments on the subject of re-melting cast-iron are well known, and have been repeated at various times in this department; when, however, the experiment is made with large masses of iron of several tons, the effect produced is not so marked. It would appear that without any considerable diminution of the impurities in the metal, as silicon, sulphur, and phosphorus, a considerable increase of tenacity and specific gravity can be obtained. The graphite is partially expelled, and some of it is converted into combined carbon, and the contraction and crystallization is more energetic and complete. This combined carbon can, it is thought by some, on again re-melting the mass, and very slowly cooling it, be reconverted to graphite, rendering the iron soft and fusible. This is undoubtedly the case with the product of the refinery process known as 'metal,' the use of which on this principle formed the subject of a patent by Dr. Price in 1856.

There is a point not probably accurately determined at which the maximum hardness corresponding to the maximum tenacity may be found. In an iron cannon there is, however, required an elasticity in addition to other qualities, when these qualities are not in excess to such an extraordinary degree as to render the mass so strong and rigid as to obviate any danger of disruption. It has been found in the various experiments made at Woolwich, that in most cases where the specific gravity is 7·3 or upwards, the metal is unsuited for gun purposes, on account of its hardness and want of elasticity; while the same iron treated in the furnace for a shorter time, and being when cast of a lower specific gravity and less tenacity, would have resisted more satisfactorily the explosion of the powder.

The most decided features to be observed in the results are the universal and very marked superiority of the bars in the cases where they have been cast horizontally over those cast vertically; and the superiority, but in a less marked degree, of the bars cooled quickly over those cooled gradually or slowly. It is to this rapid cooling and condensation that the superior strength of a 2-inch bar cast from a portion of the metal of which a gun is made is due.

This is almost universally found to be the case in the experiments hitherto made with a portion of metal taken from the dead-head, close to the muzzle of the gun, as compared with the bar cast at the time of making the gun.

The contrast as regards appearance is equally marked. In the bar a close grey rigid appearance; in the dead-head a large grain with graphitic masses joined or cemented together with a whiter and harder material.

The demand for the manufacture of iron ordnance, and the necessity for the supply of a certain number to meet what is expected in this country of a new government establishment, has prevented such various experiments being made as are desirable. At a new government foundry on the continent, established about the same time, two

years were allowed for experiments before a 'supply' was demanded. It would appear that a great deal is still to be done on this subject, and that we are only now at the commencement of vast improvements in the manufacture of cast iron and cast steel."

Extraordinary Steam Hammer.

From Herapath's Railway Journal, No. 1063.

An enormous steam hammer, on Naylor's patent principle, for the Victorian Railway Company of Australia, has just been made by the Kirkstall Forge Company, Leeds, for manufacturing large forgings. The hammer is upon the double and single action principle, that is, it is not only lifted by the pressure of steam from below, but the natural effect of gravity of the falling hammer is assisted by the pressure of steam from above. By this means additional momentum is acquired, and a blow of most extraordinary force and rapidity is produced, which is particularly advantageous in the manipulation of iron forgings of magnitude requiring a great number of blows. The work is thus finished at one heat, saving both the fuel and time of second heats, also consequent deterioration and waste of iron. The effect of the blow of this immense hammer will be equal to the momentum acquired by sixteen tons making forty blows per minute. The hammer can be made to work double or single acting, instantaneously; and by the adjusting valve gearing, the length of stroke and force of blow can be changed also instantly. In all gravity hammers the effect of the blow is dependent on the weight of the hammer, multiplied by the height of its fall, and consequently, the greater the distance it falls the greater the force of the blow, and the slower is the speed of working. In the double-action hammer thrice the force of blow can be given at double the speed. The principal dimensions and weights are—timber foundation, 26 ft. by 24 ft. 6 in., depth 13 ft.; cast iron anvil block, base 11 ft. 6 in. by 9 ft. 6 in., 30 tons weight; base plate to receive standards, 19 ft. 6 in. by 15 ft. 6 in., 14 tons weight; standards 10 ft. 6 in. apart, weight 15 tons; height from ground to top of steam cylinder, 21 ft. 6 in.; weight of all about 75 tons. Steam to work this hammer is generated from the furnace in which the work to be operated upon is heated, the boiler, upon "Balmforth's patent vertical principle," forming the chimney, and the heat passing up four flues in the same, thus economizing fuel and avoiding the expense of a brick chimney. The boiler is 6 ft. 6 in. diameter, and 30 feet long,—weight 15 tons. The weight of the whole apparatus, including boiler and mountings, is about 100 tons.—*Leeds Mercury*, Oct. 15th.

Electric Light.

In the last number of the *Cosmos* which we have received, (4th November,) the Abbé Moigno speaks of a series of experiments in progress at Chaillot, in regard to the application of the electrical light

to light-houses, and affirms that the results have been so unexpectedly favorable as to leave no doubt of the definite adoption of the new system. The electricity is generated apparently by a magneto-electrical machine moved by a steam engine of two horse power. But the most remarkable improvement is that described as follows: "Experiment has proved that by a slight modification in the electric lamp, the alternating currents may be used without any reversal. We ourselves established that two hundred interruptions per second in the direction of the current did not prevent the light from being perfectly continuous, and did no injury to the play of the regulator." And he very truly adds, "This is an immense progress, which leads to the complete solution of the problem of the electric light. The moment that we are not compelled to reverse the currents, the currents of induction may be received and transmitted without solution of continuity; there is no longer any spark, or noise, or burning, or destruction of contact; and the production of the electric light equal to several hundred Argand burners is now but child's play—and requires but little expense." What this slight modification in the lamp is, the Abbé does not mention, but we suggest the subject to our American inventors, remarking that by far the best electrical light, both as to constancy, brilliancy, and ease of management, is the arrangement invented by Eben C. Jayne, of this city. We know that he has contemplated its application to light-houses, and we hope that our Light-House Board will give him and others every facility for experimenting on so important a subject.

The Abbé Moigno also asserts, what we have not seen mentioned elsewhere, that the South Light-house at Dover, has been lighted by electrical-light in place of oil lamps, and that the results under the management of Mr. Holmes are "eminently favorable." The subject is a very important one. ED.

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*Compressed Fodder.**

An ingenious invention has just been adopted by the French Minister of War for the better feeding of cavalry horses when on the march. M. Naudin, veterinary surgeon of the Imperial Guard, has succeeded in compressing the food for the journey into small tablets like those already in use composed of vegetable food for the army. M. Naudin has given publicity to his process, and it is destined, no doubt, to render immense service to the commissariat departments in every country. The hay and straw are chopped fine, the oats and corn crushed, and then mixed in proportion to the nutritive qualities afforded by each. Upon the mixture is poured a mucilaginous residue of linseed, and the whole is pressed and comes out in a hard cake, only requiring to be dried in the oven. Although invented for the emergencies of war, this method of preserving fodder may be found most valuable in reducing the space occupied by the food of cattle on board ship, in distant encampments, or in the long marches of emigration parties. At any rate the method is a valuable extension of Chollet's invention, and has been eagerly adopted for the provender of the French cavalry of the army of Italy.

* Journal of the Society of Arts, No. 347.

Performance of the U. S. Steamer Wyoming.

To the Editor of the Journal of the Franklin Institute.

In the accounts in the *Jour. of the Franklin Institute*, October and November last, of the performances of the *Wyoming*, there are certain items which appear anomalous, and of which some scientific explanation would gratify some of your readers. Amongst them are the following:—

1. It appears that on increasing the H. P. developed from 302 to 1088, the coal per H. P. diminished from 3·60 to 2·40 lbs, thus reversing the generally received rule that the greater the boiler surface for a given quantity of work, the greater the efficiency of each lb of coal. This rule receives remarkable confirmation from the experiments in the *San Jacinto*, where two boilers as nearly as possible alike in all other respects, showed an evaporation per H. P. of anthracite of 6·827 *vs.* 7·892, the total heating surface being 2·663 *vs.* 3·073, efficiency 100 *a* 115$\frac{6}{10}$, surface 100 *a* 115$\frac{4}{10}$.

2. A similar effect seems to be produced by the condenser, the vacuum increasing with the quantity of steam condensed being 22·45 inches with 302 H. P., 22·50 with 535 H. P., and 23·34 with 791 H. P., thus differing from the rule that the power of a condenser is in some *direct* proportion to its surface.

3. The great difference between the vacuum gauge, and the vacuum shown in the cylinder by the diagram. The former being reported at 23·50, whilst the diagram (November No.) shows only from 5 *a* 10 lbs. =10 *a* 20, or a mean of 15, inches, making a difference of 8·50, or nearly 20 per cent. of the whole mean pressure or power of the engine.

4. In the diagram for November, steam cut-off at about half stroke at 22+15=37 lbs, shows at end of stroke, when its volume has been only doubled, 12 lbs.; but not so much by 50 per cent. as is generally supposed due to this expansion.

This last fact, too, is in very strong contrast with an account given by that very careful experimenter who has issued Engineering Precedents, who, on the 14th page of this work, No. 2, gives an account where 20+15=35 lbs, pressure of steam when cut-off at 22 per cent. has a final pressure of 14·8 lbs, or, with four and a half expansions, less reduction than the *Wyoming* has with two.

As it is one of your objects to reconcile art with science, I hope you will not consider the inquiries impertinent from an AMATEUR.

In reply to the above communication the attention of "Amateur" is called to the following facts:—

1st. That when only 302·3 H. P. were indicated, the machinery was comparatively new, and the friction incident to new machinery prevented the attainment of such velocity of piston as was afterwards obtained with the same pressure; while the losses from wastage of coal in the furnaces, ashes, and other impurities, radiation from surfaces of boilers, steam-pipes, cylinders, &c., priming and leakage were the same as if the engines had been moving at double the speed. Besides which, there was at that time less expansion, more wire drawing, and a lower pres-

sure of steam, all of which tend to increase the consumption per Horse Power. If *Amateur* will compare the average results of the outward and homeward passages to and from Charleston, he will note the following:—

Outward.—16·2 pounds of steam, cut-off at 10·62 inches, throttle $\frac{6}{10}$ open, and 23·29 ins. of vacuum, produced 58·2 revolutions per min.

Homeward.—16·9 pounds of steam, cut-off at 10·78 inches, throttle $\frac{7}{8}$ open, and 21·68 inches of vacuum, produced 71·45 revolutions per minute.

The average of weather during these two trips was very nearly the same: slightly in favor of the homeward trip, but not nearly enough to produce so marked an increase of speed, which was principally owing to the reduction of friction of the engines, *per se*, enabling them to attain an increased velocity and thereby to develop more power, the constant losses alluded to, remaining the same. Hence, also, it will be seen that in the homeward trip, developing 637·8 H.P., the consumption was 2·73 lbs. per H. P., against 3·17 lbs. per H. P. for 433·9 H. P. on the outward trip.

It is, of course, true that more coal per hour was consumed, but that has no bearing upon the position taken, which is that with the *same pressure* upon the piston, a less velocity was obtained, while the constant losses were unaltered; consequently a smaller per centage of the fuel was utilized, and the comparative cost of each H. P. enhanced.

As regards the consumption per H. P. during the last experiment recorded, a different (and much better) quality of coal was employed, and therefore no accurate comparison could be entered into. The rule mentioned by *Amateur* holds good only when the speed of the engines, and their friction, remain nearly the same; as was the case in the *San Jacinto*, to which he refers.

As an illustration of the above, suppose the friction of the engine, *per se*, amounts to 1·5 lbs. per sq. inch of the piston, and the mean effective pressure to 12 lbs. during the whole stroke; 10·5 lbs. will be applicable to propulsion tending to produce motion. If, instead of 1·5 lbs., it required 3 lbs. to overcome the friction, only 9 lbs. remains to produce motion. It is then obvious that less speed of piston would be the result, and consequently less power would be developed in a given time.

It should not be forgotten that (especially in marine engines) a large per centage of the coal consumed in the boiler furnaces, expends its useful effect before the steam acts upon the pistons, no matter how carefully constructed, or how well planned the machinery may be, while the power indicated on the engines is the only test we can apply to the power utilized.

2d. With regard to the vacuum produced in the condenser. There is no such rule as that supposed by *Amateur*, that the vacuum "bears some direct proportion to the surface," unless the surface is taxed to its full power. In the case of the *Wyoming*, the surface is so much in excess of what is required, that the temperature was reduced to 80° or 90° even when working off the steam from 1000 H. P. The deficiencies in vacuum were due, not to imperfect condensation, but to air leaks

at the stuffing boxes of the piston rods and air-pumps: and it was found, when these were the same, that the higher the speed of piston the higher was the vacuum attained, owing, no doubt, to the increased capacity of air-pumps thereby developed.

An examination of the logs recorded, shows that the vacuum attained bore no fixed proportion to the speed or power. On the last log, after the fresh water air-pumps had been freshly packed, 25 inches were attained at 67 revolutions; and it is probable that with continued working, this vacuum will be still further improved. A close surface condenser differs from others in this, that its capacity of air-pumps being less, and there being no other outlet for the air contained in the steam, air-tight packings are essential; and these cannot be obtained with horizontal pumps, at least, (if ever) until the machinery has worked for some time.

3d. The difference between the vacuum gauge and the back pressure in cylinders must always exist to a certain extent, and particularly in quick working engines, when it is not possible to obtain ports large enough to void the cylinders with sufficient rapidity. The length of exhaust-pipes causing friction in them and the passages, and the surplus pressure required to put the steam in motion at such high velocity, all increase this evil. In side-wheel engines moving at slow speed, this difference generally amounts to from 1 to $1\frac{1}{2}$ lbs.

Now, in the first card shown, while the vacuum gauge showed $21\frac{1}{2}$ inches, or . . . 10·75 lbs. (nearly),
the average vacuum was . 9·9 lbs.
Difference, ·8 lbs.

In the last cards, the gauge showed 23·5 inches, or 11·7 lbs, while the average back pressure was for one set, (full lines,) 9·2,
and for the other, . . . 10.
giving a mean of . . . 9·6 lbs.
Difference, 2·1 lbs.

In one of the latter, the vacuum line is, for some cause not explained, about two-thirds of the stroke in coming down to the proper vacuum.

It therefore appears, that notwithstanding the high speed, the "loss of power" from this cause, was rather less than usual, when the engines were working at 72 revolutions, and producing 640 H. P., and that it was not extraordinarily great when developing 1080 H. P., at $80\frac{1}{2}$ revolutions.

4th. In the diagram for November, although the *average* pressure of steam entering the cylinder was over 22 lbs., yet *Amateur* should not overlook the fact that in consequence of wire drawing the steam *when cut-off* at 13·7 inches from commencement of stroke, was reduced to about 19 lbs. on one, and 18 on the other, mean, 18·5; which, if Mariotte's law were strictly correct, if there were no leakage, and no condensation, would reduce its pressure to 17·16 lbs. when the exhaust valve was opened, which was after the piston performed 28·5 inches of its stroke.

$$\text{Because,}\quad \frac{13{\cdot}7+1{\cdot}9}{28{\cdot}5+1{\cdot}9}\times(18{\cdot}5+14{\cdot}7)=17{\cdot}16.$$

While in reality, by the cards it was—for one set (full lines) 14·2 and by the other 14·6 lbs. average 14·4 lbs. or 2·76 below the theoretical pressure. This difference was undoubtedly caused by condensation, and shows that the leakages could not have been large: for wherever the end pressures are equal to or greater than they ought to be, leakage is established as a condition of the case.

And in this connexion, it may be remarked, that the higher the end pressure should be, theoretically (there being no leakage), the more will the real end pressure be reduced: for with very low end pressures, a second evaporation takes place in the cylinders, due to the heat absorbed by them, reducing thereby the condensation, and of course, assimilating the pressures, real and theoretical.

As regards the case adduced by "Amateur," when $4\frac{1}{2}$ expansions of 34·7 lbs. total initial pressure, gave 14·8 lbs. final, we can only say again that, as

$$\frac{34{\cdot}7}{4{\cdot}5}=7{\cdot}71 \text{ lbs.}$$

theoretical end pressure, the difference between that and 14·8 must have been made up in some way—and we should be disposed to attribute it, principally, to leakage of the valves. J. V. M.

For the Journal of the Franklin Institute.

Aerometry. Translated from the Hydraulics of D'Aubuisson de Voisins. By J. Bennett.

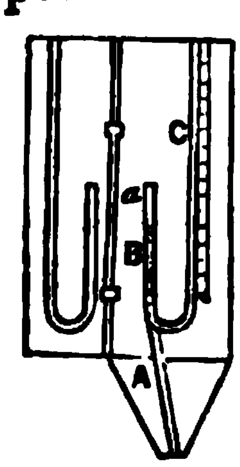
490. Aerometry, or the science of the motion of aeriform fluids, which may properly be termed aerodynamics, may be investigated under the three following conditions:—1st. When the fluids issue from the effect of compression, from a reservoir in which they are inclosed. 2d. When they move in conduit pipes. 3d. When they act as motors.

Before entering upon these subjects, let us refer to some of the properties of air, and more especially of atmospheric air.

Mechanical Properties of Air.

491. Atmospheric air, though composed of azote and oxygen, two essentially different gases, and simply mixed, is regarded in mechanics as a homogeneous body.

492. *Elasticity.*—Like all aeriform fluids, it is eminently elastic. By reason of elasticity, it constantly tends to occupy a greater space; so that when inclosed in a vase, it exerts in virtue of this tendency, an effort or pressure against the sides of the vessel. According to the principles of hydraulics, and disregarding the weight of the fluid, the pressure is equal upon all points of the sides: so that if a manometer*



* The manometer used in the experiments to be reported hereafter, consists of a glass tube bent round parallel to itself, inserted in a piece of wood with a hinged cover. The first of the three branches A B C of the tube passes behind the second: it is empty, and the two others contain in their lower half mercury or colored water. The instrument is inserted by the conical end into a circular hole made in the air reservoir. When the fluid is compressed, as it communicates through the branch A, with the top of the branch B, it presses the liquid downwards, and forces it up the branch C; then the difference of level of the liquid in the two branches is the manometric height, or measure of the elastic force.

is placed upon one of them, the height to which the mercury or other fluid may be raised, will indicate the *pressure*, or *tension*, or *elastic force* of the enclosed air.

493. *Compressibility.*—The air is compressed under the weight with which it is loaded, and in proportion to the weight. This law, established by Mariotte, and verified long since for small loads, has been confirmed by the beautiful experiments of MM. Dulong and Arago,* up to the enormous load or pressure of 67·236 feet of height, a pressure of twenty-seven *atmospheres*, or equal to twenty-seven times that due to the weight of our atmosphere, and is indicated by the height of the barometer at the level of the sea, a height generally estimated at 2·49 feet = 29·88 ins. (The most exact observations give as a mean at this level, from my computations 2·5 ft. = 30 ins., the mercury being reduced to 32° Fah. of thermometric temperature.)

494. *Dilatation by heat.*—Air is dilated by heat: and $\frac{1}{480}$ or 0·00208 its volume for each degree of Fahrenheit, starting from 32° of this thermometer; so that the volume of a mass of air, represented by 1 at 32°, will be represented by $1+0{\cdot}00208\,(t'-32°)$ at t' degrees. All aeriform fluids follow this law of dilatation, as well as that of compression proportional to the weight.

495. *Weight of Atmospheric Air.*—The density of bodies, their masses being the same, are in the inverse ratio of their volume; so that the densities of the same fluid mass at 32° and at t °, will be to each other as $1+0{\cdot}00208\,(t°-32°)$ is to 1. Weights, under the same volume, follow the ratio of the densities; and so it will be with the *specific gravity* of bodies, which is their weight at a given unit of volume.

The specific weight of an aeriform fluid will then be a function of the load which compresses, and the heat which penetrates it; it will increase with the load, and diminish with the heat, in the ratio to be indicated.

From the experiments of MM. Biot and Arago, a cubic foot of dry atmospheric air at 2·493 feet of load, or barometer pressure, and at 32° of temperature, weighs 0·08112 lbs. Thus under a barometric pressure represented by b, and at a temperature t, the weight of a cubic foot, or the specific weight of dry atmospheric air will be

$$0{\cdot}081121\,\frac{b}{2{\cdot}493}\cdot\frac{1}{1+0{\cdot}00208(t-32°)}=\cdot032533\,\frac{b}{1+0{\cdot}00208(t-32°)}$$

The aqueous vapor always existing in atmospheric air, in a greater or less quantity, being lighter than air, diminishes its weight in mixing with it; and as, other things being equal, its quantity is greater as the weather is warmer, we must regard its effect by increasing a little the multiplier of t, or raising it to ·00222. We may accordingly establish the weight of a cubic foot of atmospheric air at

$$\cdot032533\,\frac{b}{1+\cdot00222\,(t-32°)}.$$

If 1 represent the weight of a volume of dry air, remembering that the vapor of water

* Annales de Chimie et de Physique. Tome xliii, 1830.

is lighter in the ratio of 5 to 8, we find that the weight of the same volume, containing also a certain quantity of this vapor, is $1 - \frac{3\,n\,f}{8\,b}$: an expression in which b indicates the height of the barometer in this air, and $n\,f$ the elastic force of the vapor at the temperature t, in a space saturated with it; and we have

$$* f = 0^{m}\cdot 00512 \times 10^{\,0\,28\,t - 0\cdot 000063\,t^{2}}.$$

HYGROM.	n
100°	1·00
95	0·89
90	0·79
85	0·70
80	0·61
75	0·54
70	0·47
65	0·40
60	0·35
50	0·28

The number n is the ratio between the quantity of vapor contained in a space, where the hygrometer is kept at a certain degree, and the quantity contained in the same space, when it is entirely saturated, and when, consequently, the hygrometer is at 100°, the temperature being the same. M. Gay-Lussac has provided a table of the values of n, corresponding to the different degrees of the hair-hygrometer: the adjoining table is taken from it. I have elsewhere shown (1) that the substitution of the approximate factor

$$\frac{1}{1+\cdot 00222\,(t-32^{\circ})}$$

For the theoretic factor,

$$\frac{1-\dfrac{3\,n\,f}{8\,b}}{1+\cdot 00208\,(t-32^{\circ})}$$

will not occasion an error of more than a thousandth in the weight of the air taken in the usual condition of the atmosphere.

496. *Weight of Air compared with that of Water.*—A cubic foot of water weighing 62·448 lbs., and the cubic foot of air $\cdot 032533$ lbs. $\frac{b}{1+\cdot 00222\,(t-32^{\circ})}$; the ratio between these weights, which is $1919\cdot 5\,\frac{1+\cdot 00222\,(t-32^{\circ})}{b}$, expresses how many times the weight of the water exceeds that of the air; it will be 800 times, at 50° Fah., and at 2·493 feet of barometer.

497. *With Mercury.*—The cubic foot of mercury at 32° weighs

$$\frac{849\cdot 242}{1+\cdot 0001\,(t-32^{\circ})}.$$

Thus the ratio between the weight of this substance and that of air, will be

$$\frac{849\cdot 242}{\cdot 032533}\,\frac{(1+0022\,(t-32^{\circ}))}{b\,(1+\cdot 0001\,(t-32^{\circ}))} = 26103\cdot 8\,\frac{1+\cdot 00222\,(t-32^{\circ})}{b}$$

observing that the factor $\cdot 0001\,(t-32^{\circ})$ is always very small: and in neglecting it we correct somewhat the effect of vapor upon the weight of the air.

I remark that 26099 feet is the height of the atmosphere, on the supposition of a constant density, the air being throughout at 2·493 lbs. pressure and 32° of temperature.

498. *Weight of any Gas.*—Usually atmospheric air is taken as a term of comparison with other aeriform fluids or gases; if p be the ratio of density of any gas to that of air, or the *specific weight* of the gas, the weight of a cubic foot will be

$$\cdot 032533\,p\,\frac{b}{1+\cdot 00222\,(t-32^{\circ})}.$$

* In metrical units; t being in centigrade divisions.

SECTION FIRST.

The motion of air issuing from a reservoir in which it is compressed.

499. *Force by virtue of which the fluid issues.*—Let us take for the reservoir a tight box, containing air in its natural state, or at the simple pressure of the atmosphere, a pressure which we always distinguish by b: if we make an opening at one of the sides, the molecules of air in its vicinity, being pressed on all sides alike, by the same force (effort) b, will remain in equilibrium; they will not issue and there will be no motion.

But if the interior air receives a pressure: for example, if the cover of the box be movable as a piston in the body of a pump, and charged with a weight, the air will be more pressed than that outside; and its molecules, yielding to the excess of pressure, will issue. Suppose a manometer fitted to the box is raised the height H, this height will measure the resultant pressure of the weight upon the cover; the molecules in front of the opening will be urged outwards by the force $b+\text{H}$; they will be repelled by b: these two forces, acting in opposite directions, will have for a resultant their difference, which is H. The issue will take place as if this force alone acted upon the air of the reservoir, and it issued in a void.

500. *Velocity of issue.*—It is known that when a fluid issues from a vessel, by virtue of a pressure exerted upon it, its velocity is due to a height equal to that of a column of issuing fluid, whose weight is a measure of the pressure. This height is evidently H increased in the ratio of the density of the manometric fluid, to that of the issuing fluid. D being the first of these densities, and d the second, calling V the velocity of issue, we shall have

$$\text{V}=\sqrt{2g.\,\text{H}\frac{\text{D}}{d}}.$$

If the manometric fluid is mercury, the air issuing under the pressure $b+\text{H}$, and having the temperature 32°, we have

$$\frac{\text{D}}{d}=26103{\cdot}8\frac{1+00222\,(t-32^\circ)}{b+\text{H}}(497):$$

Consequently, reducing and making $1+{\cdot}00222\,(t-32^\circ)=\text{T}$.

$$\text{V}=1296\sqrt{\text{H}\,\frac{\text{T}}{b+\text{H}}}.$$

In case of H being neglected by reason of its small ratio to b, this last quantity being usually estimated at 2·493 feet, and admitting a temperature of 53·6°, we shall have

$$\text{V}=840{\cdot}4\sqrt{\text{H}}.$$

501. *Discharge.*—If S represent the area of section of orifice, the volume of air flowing in a second of time will be

$$1296\,\text{S}\sqrt{\text{H}\frac{\text{T}}{b+\text{H}}}.$$

This is the theoretic discharge.

But here also, the contractions experienced by the vein of air, in its passage through an orifice, reduce the discharge.

Let m be the co-efficient of reduction, and Q the actual discharge, we shall have

$$Q = 1296\, m\, S \sqrt{H \frac{T}{b + H}}.$$

502. *Experiments to determine Co-efficients.*—We must now determine m for different kinds of orifices. I have devoted myself to this determination, and have made numerous experiments upon the subject, the details of which were published in the *Annales des Mines*, (Tome xiii, 1826.) I proceed to give a table of results, after giving a description of the apparatus used.

The principal part was a gasometer or cylindrical box, open underneath, with a diameter of 2·13 feet and 2·62 feet high. On its upper end, carrying a manometer with colored water, I made at random orifices or ajutages differing in form and size. This gasometer was placed upon a cask full of water in which it descended, being enclosed between four vertical iron rods; it was charged successively with 17·64, 35·28, 52·92, 70·56, and 83·2 lbs., and sometimes with 4·41, 8·82, 13·23, and 26·46 lbs. so as to vary the velocities of the issuing air.

From the indications of the manometer, and the area of the orifices, was derived the theoretic discharge. By multiplying the section of the gasometer by the height of its fall per second, a height derived from the number of seconds required for its descent from a given elevation with a uniform motion, we have the real discharge. This divided by the first, gives the co-efficient sought.

503. *Orifices in a thin side.*—The air at first issued through circular orifices pierced in tin-plate, and the following results were obtained:

Diameter of Orifice.	Manometric Height.	Length of Descent.	Time of Descent.	Co-efficient. By Experiment.	Co-efficient. Mean.
ft.	ft.	ft.	seconds.		
·032	·0938	1·96	187	·623	
·032	·1640	1·96	141	·629	
·032	·2394	1 96	117	·628	·630
·032	·3215	1·96	102	·623	
·032	·3936	1·80	82	·642	
·032	·4724	1·80	76	·634	
·049	·0918	1·96	82	·643	
·049	·1640	1·96	60	·660	
·049	·2362	1·96	51	·647	·652
·049	·3215	1·47	32	·664	
·049	·4002	1·80	36	·648	
·065	·0885	1·96	46	·665	
·065	·1246	1·96	39·5	·642	·646
·065	·1640	1·96	34·7	·636	
·065	·1968	1·96	31·5	·641	
·098	·0885	1·96	20	·656	
·098	·1049	1·96	18	·686	
·098	·1246	1·96	16·5	·683	·673
·098	·1443	1·96	15·5	·675	
·098	·1640	1·96	14·7	·664	
			General Mean,	.	. ·649

A discussion of these different experiments causes us to adopt 0·65 as the co-efficient of reduction for orifices made in a thin plate.

For the running of water we had as a mean 0·62.

The diminution in the discharge of air, is then the effect of a real contraction of the fluid vein; this may be rendered apparent by charging the air with smoke, when the contraction of the vein becomes distinct at its issue from the orifice.

NOTE.—A Swedish savan, Lagerhjelm, has also made experiments upon the flow of air through orifices in a thin plate. Their diameter was ·039 feet, ·078 feet, and ·108 feet; the manometric pressures were from ·190 feet, up to 1·571 feet; the co-efficients obtained varied from 0·58 to 0·70, and their mean term was at 0·62. Most frequently the flow, having but a few seconds duration, and the results not presenting the same uniformity as ours, we cannot equally confide in them.

504. *Cylindrical ajutages.*—The cylindrical ajutages, or small additional tubes which I used, had the same diameters as the circular orifices. They afforded the experiments shown in the following table:

AJUTAGE.		Manometric Height.	Length of Descent.	Time of Descent.	CO-EFFICIENT.	
Diameter.	Length.				By Exper't.	Mean.
ft.	ft.	ft.	ft.	seconds.		
·0328	·1312	·0885	·1968	132	·910	·931
·0328	·1312	·1640	·1968	97	·912	
·0328	·1312	·2362	·1968	79·7	·925	
·0328	·1312	·3116	·1968	68	·947	
·0328	·1312	·3936	·1804	61	·920	
·0328	·1312	·4625	·1804	51·5	·940	
·0492	·1476	·0885	·1968	59	·923	·924
·0492	·1476	·1640	·1968	43·5	·922	
·0492	·1476	·2362	·1968	36	·930	
·0492	·1476	·3149	·1804	29	·927	
·0492	.1476	·3936	·1804	26	·916	
·0656	·1968	·0918	·1968	33	·896	·916
·0656	·1968	·1640	·1968	24·2	·915	
·0656	·1968	·2362	·1968	19	·934	
·0656	·1968	·3149	·1804	16	·919	
·0984	·2624	·0820	·1968	14	·964	·933
·0984	·2624	·1017	·1968	13·3	·934	
·0984	·2624	·1279	·1968	12	·902	
				Mean,	. .	·926

The accordance in these results is remarkable; it leaves no doubt as to the value of the co-efficient for cylindrical ajutages; it is from 0·92 to 0·93.

That of incompressible fluids, 0·82, was much less.

505. It was desirable to know to what point the length of the additional tube might affect the value of the co-efficient. In consequence, four tubes of ·049 ft. diameter, whose lengths are given in the following table, were chosen.

Length of Tube.	Co-efficient.	DISCHARGE.	
		Real.	Calculated.
ft.		cubic feet.	cubic feet.
0·049	·938	·02571	·02489
0·147	·924	·02472	·02468
0·531	·838	·02217	·02263
1·066	·738	·02013	·02051

Many series of experiments were made on each; in the third column is given the mean discharge obtained, and in the second, the co-efficient derived from it.

The rapidity of the decrease is very marked, and the theory to be unfolded in the next chapter, upon the effect of the resistance opposed by tubes to the motion of air, takes note of it, as appears from the last column of the table, which presents the discharge calculated in accordance with the theory.

506. *Conical ajutages.*—We pass to conical ajutages, those most generally used.

The better to compare their effects with those of cylindrical ajutages, the same orifice of issue and the same length were given to them.

AJUTAGE.						CO-EFFICIENT.	
Diameter at		Length.	Height manometric.	Length of Descent.	Time of Descent.	By Experim't.	Mean.
Outlet.	Inlet.						
ft.	ft.	ft.	ft.	ft.	seconds.		
·0328	·0656	·1312	·1640	1·968	96	·928	·927
·0328	·0656	·1312	·2362	1·968	81	·917	
·0328	·0656	·1312	·3149	1·968	69	·934	
·0328	·0656	·1312	·3930	1·968	62	·930	
·0492	·0984	·1476	·0918	1·968	57·5	·913	·917
·0492	·0984	·1476	·1640	1·968	43	·916	
·0492	·0984	·1476	·2362	1·968	36	.915	
·0492	·0984	·1476	·3149	1·804	28·5	·927	
·0492	·0984	·1476	·3930	1·804	25	·916	
·0656	·1312	·1968	·0885	1·968	32	·945	·936
·0656	·1312	·1968	·1213	1·968	27·5	·951	
·0656	·1312	·1968	·1640	1·968	24	·928	
·0656	·1312	·1968	·1968	1·968	22	·924	
·0984	·1968	·2624	·1312	1·968	12	·924	·933
·0984	·1968	·2624	·1640	1·968	11·5	·942	
				General Mean,	.	.	·928

Thus, for conical ajutages as well as for cylindrical, the co-efficient is 0·93.

507. Wishing to know the effect of conical ajutages in the proportion of their convergence, or the increase of the angle formed by the opposite sides of the cone, I made five ajutages, all having at the outlet an orifice ·049 ft., but with different angles. They served me for a series of experiments similar to the others; I limit myself to giving the derived co-efficients.

AJUTAGE.		The manometric height being at					Co-efficient mean.
Angle of convergence.	Length. ft.	·092 ft.	·164 ft.	·236 ft.	·315 ft.	·039 ft.	
6° 26′	·1476	·939	·939	·940	·933		·938
18° 54′	·1476	·912	·916	·915	·927	·916	·917
53° 08′	·1476	·786	·810	·797	·803	·794	·798
11° 24′	·0820	·946	·939	·949	·960	·951	·947
28° 04′	·0328	·888	·877	·881	·881	·874	·880

A glance at the table shows the advantage of short and slightly converging ajutages. When the angle of convergence does not exceed from 10° to 12°, the co-efficient will be ·94 nearly: as it becomes greater, the co-efficient and discharge diminish, and we approximate to the phenomena presented by orifices in a thin side.

508. According with these facts, the value of m in the expression of discharge

$$1296\, m\, \mathrm{s}\sqrt{\mathrm{H}\,\frac{\mathrm{T}}{b+\mathrm{H}}},\text{ will be}$$

·65 for orifices in a thin side.
·93 for cylindrical ajutages.
·94 for slightly conical ajutages.

509. *Discharge through Nozzles.*—Nearly all the ajutages used in practice, such as the nozzles at the end of wind trunks in manufactories, of bellows, falling in with the last conditions, ·94 will often be the suitable co-efficient; still, on account of their length, and for greater surety, we shall adopt for these nozzles, ·93. Then, observing that $\mathrm{s}=·785\, d^2$, d being the diameter of the outlet orifice, we have

$$\mathrm{Q}=848·18\, d^2\sqrt{\mathrm{H}\,\frac{\mathrm{T}}{b+\mathrm{H}}}.$$

In the volume given by this expression, the air is supposed to be of the same density as that of the interior of the reservoir from which it issues, and consequently to be under the pressure $b+\text{H}$. We may transform this volume into that which the same mass of air would occupy under a given pressure b' by multiplying the above value by the ratio $\frac{b+\text{H}}{b'}$ of the two pressures; moreover, we usually take the air under the atmospheric pressure supposed to be 2·4934 ft.; then $b'=2{\cdot}4934$ feet, and we have

$$\text{Q}=\frac{948{\cdot}18}{b'}d^2\sqrt{\text{H}\,(b+\text{H})\,\text{T}}=380\,d^2\sqrt{\text{H}\,(b+\text{H})\,\text{T}}.$$

510. If we wish to have the weight of the mass of air discharged in a unit of time, we multiply the first of the two values of Q just given by

$$\cdot 032533\,\frac{b+\text{H}}{1+\cdot 00222(t-32)},$$

the weight of a cubic foot of air under the pressure $b+\text{H}$, and at the temperature t (495), so that if P represents in pounds the weight sought, we shall have

$$\text{P}=30{\cdot}787\,d^2\sqrt{\text{H}\,\frac{b+\text{H}}{\text{T}}}.$$

511. In applications we usually adopt for b and t the mean values of the heights of barometer and of thermometer in the place of experiments.

If l is the latitude of the place, and e its approximate elevation above the level of the sea, we have

$$b=2{\cdot}5\text{ feet}-0{\cdot}00009\,e, \qquad (433)$$
$$t=82{\cdot}8\cos l-\cdot 001981\,e-0{\cdot}4.$$

We may also without any very serious error, cancel b and t of the formulæ, substituting for them a mean for a great extent of country; thus, for France, we would make $t=53°6$ or $\text{T}'=1{\cdot}048$, $b=2{\cdot}46$ ft., and $b+\text{H}=2{\cdot}559$ ft., and we shall have

$$\text{Q}=621{\cdot}28\,d^2\sqrt{\text{H}}\text{ cubic feet, and}$$
$$\text{P}=48{\cdot}073\,d^2\sqrt{}\text{ pounds.}$$

512. *General discharge for Gas.*—The principles which we have established, and the rules we have deduced for the flow of atmospheric air, apply to that of other aeriform fluids, with modifications depending upon the density of each.

Let there be, for example, a gas whose density in its ratio to that of the manometric fluid is d, and which issues from a reservoir, under a manometric pressure H. Its velocity of issue will be due to the height H, increased in the ratio of the density of mercury to that of the gas (500); and Q being the volume of the discharge per second of the latter, we shall have

$$\text{Q}=m\,\text{S}\sqrt{2\,g\,\frac{\text{H}}{d}}.$$

For another gas, of which d' is the density, and Q′ the volume discharged, all else being equal, we shall have

$$\text{Q}'=m\,\text{S}\sqrt{2\,g\,\frac{\text{H}}{d'}}.$$

Thus,
$$\text{Q}:\text{Q}'::\sqrt{\frac{1}{d}}:\sqrt{\frac{1}{d'}}::\sqrt{d'}:\sqrt{d};$$

that is to say, *the volumes of two gases flowing through equal orifices, and under equal pressures, are in the inverse ratio of the square roots of their respective densities.*

Consequently, if atmospheric air is one of the gases, and p is the specific weight of the other (498), the ratio of the densities being that of 1 to p, the discharge of the last gas will be

$$\frac{380\ d^2}{\sqrt{p}}\sqrt{\text{H}\ (b+\text{H})\ \text{T}}.$$

513. *Examples.*—Required the volume of atmospheric air reduced to a barometric pressure of 2·477 ft., which a reservoir will furnish, upon which the mercury-manometer stands at ·098 ft., and to which is fitted a nozzle ·246 ft. in diameter. It is in the 45th degree of latitude, and 656 ft. above the level of the sea.

In such a place we have as a mean (511) $b=2{\cdot}44$ ft., and $t=55{\cdot}4°$; according to the above data we also have $\text{H}={\cdot}098$ ft., $d={\cdot}246$ ft., and $b'=2{\cdot}477$; consequently, $\text{T}=1{\cdot}052$ and $b+\text{H}=2{\cdot}539$.

The volume of air discharged in 1 sec. will then be (509)

$$948{\cdot}18\ \frac{({\cdot}246)^2}{2{\cdot}477}\sqrt{{\cdot}098\times2{\cdot}539\times1{\cdot}052}=11{\cdot}85.$$

Thus the reservoir will deliver 11·85 cub. ft. of air per second; such a quantity is sufficient to keep in action the fire of four or five large refining forges.

514. What should be the height of the mercury column in the manometer to cause a discharge through a nozzle ·19 ft. diameter of ·7 lbs. of atmospheric air in 1 sec.? The barometer as a mean stands at 2·46 ft., and the thermometer at 51·8°.

From the relation

$$\text{P}=30{\cdot}787\ d^2\sqrt{\text{H}\ \frac{b+\text{H}}{\text{T}}};$$

by squaring and solving the equation of the second degree, we deduce

$$\text{H}=-\tfrac{1}{2}\,b+\sqrt{\frac{\text{P}^2\ \text{T}}{(30{\cdot}787)^2\ d^4}+\tfrac{1}{4}\,b^2}.$$

Here we have $\text{P}={\cdot}7$ lbs., $b=2{\cdot}46$ ft., $d={\cdot}19$ ft., and $\text{T}=1{\cdot}044$. These quantities substituted in the above equation give $\text{H}=0{\cdot}158$; thus the required manometric height sought is ·158 ft.

If we had used the more simple formula (511)

$$\text{P}=48{\cdot}073\ d^2\sqrt{\text{H}}$$

we should have

$$\text{H}=\frac{{\cdot}7^2}{(48{\cdot}073)^2\ ({\cdot}19)^4}=1627.$$

515. A gasometer discharges 9·8109 cub. ft. of illuminating gas per second, under a charge represented by a column of water ·147 ft.; required the size of the orifice to be made in the side of the gasometer to produce this flow. The barometer in this locality is usually at 2·477 feet, and the thermometer at 59°.

We have then $b=2{\cdot}477$ ft., and $\text{T}=1{\cdot}06$; moreover $\text{Q}=9{\cdot}8109$ cub. ft. per second; and a manometric column of water of ·147 ft., is equivalent to one of mercury of

$$\frac{{\cdot}147}{13{\cdot}6}={\cdot}010808\ \text{ft.}=\text{H}.$$

The specific weight of illuminating gas (carburetted hydrogen) is, according to Berzelius and Dulong, $\cdot559=p$. The gasometer being made of copper sheets, the orifice will be made in a thin side, and the corresponding value of $m=0{\cdot}65$.

The general equation (508 and 512)

$$\text{Q}=\frac{1296\ m\ s}{\sqrt{p}}\sqrt{\text{H}\ \frac{\text{T}}{b+\text{H}}}$$

gives here

$$s=\frac{9{\cdot}8109\times\sqrt{{\cdot}559}\times\sqrt{2{\cdot}477+{\cdot}010808}}{1296\times{\cdot}65\quad\times\sqrt{{\cdot}010808+1{\cdot}06}}={\cdot}1283.$$

Thus the required orifice will have a surface of ·1283 sq. ft., or a square with its sides equal to ·358 ft., or if circular, ·403 ft. diameter.

(To be Continued.)

*Note on Steinbühl-yellow, a new kind of Chrome-yellow.**

By Dr. L. Pappenheim.

Under the above name a yellow color has been for some time in commerce which is quite certain to find much favor, although its price is far higher than that of the ordinary chrome-yellow. It is of a splendid yellow, and differs essentially in its tint from the best samples of chrome-yellow. It is pulverulent, of small specific gravity, loses nothing in weight at a red heat, but becomes transitorily reddish-brown, and is partially taken up by water without entirely dissolving in that fluid. It dissolves in muriatic and nitric acids; if the acid is poured over it in a concentrated state, a slight effervescence takes place.—When prepared with but little acid the solution is somewhat turbid, but does not leave any considerable portion when filtered. When heated with alcohol, the solution in muriatic acid becomes intensely dark-green; if more alcohol and then sulphuric acid be added, a white precipitate is produced. Solution of sulphate of lime does not precipitate the solution of the color in muriatic acid, but this is done by sulphuric acid with or without the addition of alcohol. The reddish-yellow color of the solution in nitric acid, changes by heating, with the addition of alcohol, into a beautiful blue. If acetate of lead be added to the dilute solution in nitric acid, a heavy precipitate of the color of chromate of lead makes its appearance. If an excess of lead were added, filtered, the excess of lead and the lime precipitated by sulphuric acid, alcohol added, filtered and evaporated, large quantities gave a residue, which, when dissolved in water and mixed with chloride of platinum with the addition of muriatic acid, furnished octahedra of platinochloride of potassium. The investigation gave no magnesia or other bases except lime and potash. Of acids, besides the chromic acid, which was undoubtedly present from the preceding experiments, there was only a small quantity of sulphuric acid.

When the author mixed a hot saturated solution of bichromate of potash with a saturated solution of chloride of calcium, a precipitate was produced, which, when washed and dried, was undistinguishable from the Steinbühl-yellow.

The substance gave 3·1 per cent. to distilled water after short stirring. With nitrate of silver, the yellow filtrate gave a red precipitate of chromate of silver, which was rapidly converted into white chloride of silver on the addition of a few drops of muriatic acid. Sulphuric acid and alcohol produce a strong turbidity in the filtrate. When boiled with reducing organic matters and muriatic acid, the yellow filtrate loses its color, without, however, acquiring more than a tinge of green. Acetate of lead precipitates the yellow filtrate, with the color of chromate of lead. Chloride of platinum produces a very slight turbidity in the original filtrate. Even in 16 hours no precipitate is deposited.

The Steinbühl-yellow consists, therefore, of chromic acid, lime, and potash; when stirred for a short time with cold water, it parts with chromate of lime.

* From the Lond. Chemical Gazette, No. 409.

The poisonous qualities of chromic acid and its soluble salts, and the circumstances that the color parts with perceptible, although not large quantities of chromic acid to cold water, render the Steinbühl-yellow an extremely dangerous coloring matter, the employment of which in confectionery and similar trades must not be thought of.—*Monatsblatt des Gewerbe-Vereins zu Köln*, May, 1859; *Polytechnic Centralblatt*, 1859, p. 973.

For the Journal of the Franklin Institute.

Particulars of the Steamer Seth Grosvenor.

Hull built by Henry Steers. Machinery by Allaire Works, New York. Superintended by Charles H. Haswell. Intended service, Coast of Africa. Built by the New York State Colonization Society, to run from Monrovia to Cape Mount.

HULL.—			
Length on deck,		95 feet.	
Breadth of beam, molded,		16 "	10 inches.
Frames—7 ins. by 3 ins., and 16 ins. apart from centres.			
Bulkheads—one.			
Keel,	4 ins.		
Depth of hold to spar deck,		5 "	
Length of engine space,	27 by 6 ft.		
Draft of water,		3 "	
Tonnage,	68.		
Area of immersed section at load draft of 3 ft.,	39 sq. ft.		
Masts—two. Rig—Schooner.			
ENGINE.—Steeple.			
Diameter of cylinder,			28 inches
Length of stroke,		3 feet.	
BOILER.—One—Return tubular.			
Length of boiler,		12 feet	6 inches
Breadth "		5 "	9 "
Height " exclusive of steam chests,		6 "	10 "
Number of furnaces,	one.		
Breadth "		5 "	
Length of grate bars,		4 "	6 "
Area of grate surface,	22·5 sq. ft.		
Number of tubes,	36.		
Internal diameter of tubes,	30 of 4 ins. and 6 of 3 ins.		
Length of tubes,		9 "	
Lower flues,	4.		
Diameter of flues,	2 of 8 ins. and 2 of 15 ins.		
Area of flues,	453 sq. ins.		
" tubes,	367 "		
" chimney,	530 "		
Heating surface,	540 sq. ft.		
Diameter of steam chimney,		2 "	2 "
Height "		5 "	
Diameter of smoke pipe,			28 "
Height "		24 "	
Consumption of coal per day,	4 tons.		
PADDLE WHEELS.—			
Diameter, over boards,		13 feet	6 inches.
Length of blades,		3 "	
Depth "			15 "
Number "	14.		

Remarks.—One independent steam, fire, and bilge pump. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer New London.

Hull built by Geo. Greenman & Co., Mystick Corner. Machinery by C. H. Delamater, New York. Owners, New London Propeller Co.

Hull.—			
Length on deck,		135 feet.	
Breadth of beam, molded,		26 "	
Frames—molded, 12 ins.—sided, 8 and 9 ins.—apart at centres, 24 ins.			
Depth of hold,		8 feet	6 inches.
Draft of water,	forward, 8 feet, aft,	10 "	
Tonnage,	260.		
Masts, three—Rig, schooner.			
Engines.—Vertical direct.			
Diameter of cylinder,			34 inches.
Length of stroke,		2 feet	6 "
Cut-off—one-third.			
Boiler.—One—Return tubular.			
Length of boiler,		18 feet.	
Breadth "		8 "	8 inches.
Height " exclusive of steam chimney,		8 "	8 "
Number of furnaces,	2.		
Breadth "		3 "	3 "
Length of grate bars,		7 "	
Number of flues,	above, 16—below, 10.		
Internal diameter of flues, above,			8 "
Internal diameter of flues, below, 8 of 9½ inches, and 2 of			16 "
Length of flues, above,		12 "	10 "
Length of flues, below,		9 "	8 "
Diameter of smoke pipe,		3 "	
Propeller.—			
Diameter of screw,		9 feet.	
Length "		1 "	6 inches.
Pitch "		17 "	
Number of blades,	4.		

Remarks.—One independent steam, fire, and bilge pump. Date of trial, November, 1859. C. H. H.

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*Resistance to Shot of Iron and Steel Plates.**

A series of experimental trials have been carried on during the past month at Portsmouth, with a view of ascertaining the amount of resistance offered by iron and steel plates of various manufactures when opposed to heavy ordnance at a short range. The trials had reference to the future coating of the steam ram now in progress of construction. The practice has been carried on from the *Stork* gunboat, tender to Her Majesty's ship *Excellent*, gunnery ship in Portsmouth harbor, both from a 32 pounder and a 95 cwt. gun, the latter throwing a solid 68 lb. shot, with 16 lb. charge of powder; the distance of range 200 yards. At this distance the results of the experiments have demonstrated that no iron or steel plate that has yet been manufactured can withstand the solid shot from the 95 cwt. at a short range. The first shot would not penetrate through the iron plate, but it would fracture

* From the Lond. Civ. Eng. and Arch. Journal. Sept., 1859.

it, and on three or four striking the plate in the same place, or in the immediate neighborhood, it would be smashed to pieces. As the results of the trial affected the steel plates, it proved that a steel-clothed ship could be far more easily destroyed than a wooden-sided one, and that on the smashing in of one of the steel plates the destruction of life on the armed ship's decks, supposing the broken plate to be driven through the ship's side, would be terrible, from the spread of the splintered material. At from 600 to 800 yards iron-clothed ships would be in comparative safety from the effects of an enemy's broadside, but the effects of concentrated firing have yet to be ascertained on the sides of an iron or steel-clothed ship, and account also must be taken of the damage the wood-work forming the inner sides of such a ship would receive from the driving in of the broken plates, and which, as far as the present experiments have illustrated, would appear to prove that an iron or steel-clad ship, on receiving a concentrated broadside from a frigate, armed in a similar manner to the *Mersey*, and struck near her water-line, must sink then and there, with her armor on her back.

For the Journal of the Franklin Institute.

Particulars of the Steamer Florida.

Hull built by E. S. Whitlock. Machinery by C. H. Delamater, New York. Owners, O. Nelson & Co.

Hull.—			
Length on deck,		180 feet.	
Breadth of beam (molded),		31 "	
Frames—molded, 12 ins.—sided 14 ins.—apart at centres, 26 ins.			
Depth of hold,		9 "	
" to spar deck,		16 "	
Draft of water,	forward, 9 feet 6 ins.—aft,	10 "	
Tonnage,	300.		
Masts, two—Rig, schooner.			
Engine.—Vertical direct.			
Diameter of cylinder,			36 inches.
Length of stroke,		3 feet	6 "
Cut-off—one-third.			
Boiler.—One—Return flue.			
Length of boiler,		24 feet.	
Breadth "		10 "	6 inches.
Height " exclusive of steam chimney,		11 "	10 "
Number of furnaces,	2.		
Breadth "		4 "	6 "
Length of grate bars,		7 "	6 "
Number of flues,	above, 20—below, 10.		
Internal diameter of flues,	above,		6 "
	below, 8 of 13½ ins., 2 of		20 "
Length of flues,	above, 16 ft. 2 ins.—below,	10 "	8 "
Diameter of smoke pipe,		3 "	11 "
Propeller.—			
Diameter of screw,		10 feet.	
Length "		3 "	6 inches.
Pitch "		18 "	
Number of blades,	4.		

Remarks.—One independent steam, fire, and bilge pump. Date of trial, October, 1859.

C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer Daylight.

Hull built by Samuel Sneden. Machinery by C. H. Delamater, New York. Intended service, New York to Providence.

Hull.—			
Length on deck,		170 feet.	
Breadth of beam,		29 "	8 inches.
Frames—molded, 14 ins.—sided, 8 ins.—apart from centres, 24 ins.			
Depth of hold to spar deck,		10 "	
Draft of water, forward, 11 feet, aft,		13 "	
Tonnage,	460.		
Area of immersed section at load draft of 12 ft.,	300 sq. ft.		
Masts, three. Rig, schooner.			
Engines.—Vibrating lever (Ericsson's).			
Diameter of cylinder,			40 inches.
Length of stroke,		2 feet.	
Boilers.—Two—Horizontal tubular.			
Length of boilers,		18 feet.	
Breadth "		7 "	6 inches.
Height " exclusive of steam chimney,		7 "	6 "
Number of furnaces,	one each.		
Breadth "		4 "	4 "
Length of grate bars,		6 "	3 "
Number of tubes, above,	63.		
" flues, below,	6.		
Internal diameter of tubes, above,			4 "
" flues, below,		1 "	2 "
Length of tubes, above,		14 "	10 "
" flues, below,		8 "	2 "
Heating surface,	2600 sq. ft.		
Diameter of smoke pipes,		3 "	
Height "		30 "	
Propellers.—			
Diameter of screw,		11 feet	4 inches.
Length "		2 "	
Pitch "		19 "	
Number of blades,	4.		

Remarks.—One independent steam, fire, and bilge pump. Date of trial, November, 1859.

C. H. H.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, January 19, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

A letter was read from G. Rush Smith, Esq., Pennsylvania Legislature, Harrisburgh, Penna.

Donations to the Library were received from the Royal Society, the Zoological Society, the Institute of Actuaries, and P. Lutley Sclater, Esq., London; the Royal Cornwall Polytechnic Society, Falmouth, and

the Literary and Philosophical Society, Liverpool, England; the Oesterreichischen Ingeniuer-Verienes, and the Geologischen Reichsanstalt, Wien, Austria; L. A. Huguet-Latour, Esq., Montreal, Canada; the N. O. School of Medicine, New Orleans, La.; the Cooper Union for the Advancement of Science and Art, City of New York; Messrs. A. B. and E. Latta, Cincinnati, Ohio; G. Rush Smith, Esq., Pennsylvania Legislature, Harrisburgh, Pa.; and from the American Philosophical Society, and Professors B. Howard Rand, John C. Cresson, and John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of December, and his annual statement for 1859, were read.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (10) were proposed, and the candidates proposed at the last meeting (9) were duly elected.

John M. Gries, Esq., from the Board of Managers, read the report made to the Board at their last meeting by a special committee appointed by them, to inquire into and report on the financial state of the Institute.

On motion, the report was referred to the new Board of Managers, elected this evening, with a request that they take an early action on it.

The Tellers of the Annual Election for Officers, Managers, and Auditors, for the ensuing year, reported the result, when the President declared the following gentlemen duly elected:—

John C. Cresson, President.

John Agnew,
Matthias W. Baldwin, } Vice Presidents.

Isaac B. Garrigues, Recording Secretary.

Frederick Fraley, Corresponding Secretary.

John F. Frazer, Treasurer.

MANAGERS,

Samuel V. Merrick,	Thomas J. Weygandt,	James Dougherty,
Thomas Fletcher,	Joseph J. Barras,	George Whitney,
Edwin Greble,	George Erety,	Edward P. Eastwick,
Thomas S. Stewart,	Evans Rogers,	Washington Jones,
Alan Wood,	Robert Cornelius,	William Harris,
John E. Addicks,	William Sellers,	John E. Wootten,
Isaac S. Williams,	James H. Bryson,	Joseph Hutchinson,
George W. Conarroe,	John M. Gries,	Joseph W. Moore.

AUDITORS.

Samuel Mason, James H. Cresson,
Samuel B. Finch.

At a meeting of the Board of Managers, held January 19th, 1860, the following officers were elected for the ensuing year.—

William Sellers, Chairman.

Isaac S. Williams,
James H. Bryson, } Curators.

J. Daniels, of No. 805 Market Street, exhibited his Plantarium or

plant case, which is claimed to possess advantages over the Waltonian case, as:—Facility of access from the top or the back, giving the operator a better chance to handle and arrange the plants, or to remove the tray. It is so made as to be increased in capacity if required. The top is formed of glass plates, which can be moved so as to give an opening at the apex for the escape of moisture, should it be in excess. The heating apparatus is a galvanized iron tank containing water, under which the alcohol lamp is placed. By filling the tank with hot water, morning and evening, the lamp may be entirely dispensed with.

The Skaters' Club of the City of Philadelphia, sent for the inspection of the meeting, samples of the skates manufactured in this city, as well as one imported from Prussia. One pair, by W. Bushnell, of beautiful appearance and finish, was exhibited at the Paris Exhibition and obtained the award. Another, by Clarenbach & Herder, not so ornamental, but equally well finished and proportioned, with others of lighter make, intended for female use, were in the lot. Also, a skating boot with a sock over it, intended to keep the foot warm. All the skates of American make, had a simple and efficient way of securing the heel of the skate to the foot. A T shaped piece projects from the centre of the heel of the skate, which, by placing the skate at right angles to the foot, can be passed through an oval hole cut through a metal plate which is secured to the heel of the boot; then, by turning the skate until its direction coincides with that of the foot, the shoulders of the piece catch under the plate and clamp the two together, securing the part most liable to get loose when fastened in the ordinary way by straps and buckles.

A. C. Jones, in bringing before the meeting his "self-tightening joint," stated that with the exception of metallic surfaces, all joints in use depended on the ridged end-surfaces of the pipes compressing the interposed material, by screw bolts or other mechanical means; and, as is well known, such joints usually become leaky or "blown out." In long lines of steam pipe, such as may be seen in factories and sternwheel steamboats, when the supports of the pipe yield by settling, the joints either leak, or the pipe becomes fractured, and loss of lives has resulted from the sudden escape of steam; also detention and expense to repair. In introducing the self-tightening principle, the patent will cover a new and large field, and supplies a want long felt for a joint which is unlimited in size and pressure, has a limited amount of movement at the connexion without impairing its tightness, and can be quickly connected or disconnected.

A steam-pipe joint (or any other) can be made cheaper and neater than the flanched one, and, for long lines, it dispenses with the use of stuffing-boxes, and avoids the strain from expansion and contraction, so injurious to other joints. If the pipes get out of line, they will be neither fractured nor leak, and may be adjusted simply by raising the pipe in line.

In the "union" or screw coupling, the constant tightening compresses the lead or elastic material so much, as in time, to reduce the passage to a small size; with the self-tightening joint, the bore remains the same, and the joint continues tight without the use of a wrench.

In laying water pipe in the street, the operation is tedious and very expensive; and, if a heavy rain sets in before the joints are run, the work has to be done over again, leaving open trenches to the detriment of the public.

If a branch is to be inserted, the main pipe has to be cut in two places, a slow operation in a trench.

With the self-tightening joint, a narrower trench will suffice, and the pipes can be laid in wet or dry weather, nearly as fast as they can be handled and placed in line; if a branch is to be put in, two contiguous pipes can be removed without injury (to be used again), and the branch speedily inserted.

The fire-hose coupling shown is self-acting; it locks itself simply by pressing the male into the female, making a safe union, and the water pressure makes its own joint; it is uncoupled without any tools, by a finger and thumb raising one pawl or clamp.

It was intended, if the weather had been cold enough, to show this coupling to the meeting in a frozen state, to prove the ease with which it could be opened when there was solid ice inside and around it, a test which it has been submitted to many times without injury during the coldest weather; and uncoupled in the open air, with one finger and thumb, without tools of any kind except a small block of wood to break the mass of ice.

Its rounding form (independent of its compressive strength) would prevent any road wheels remaining on it for an instant, to crush it. Its whole surface is smooth, presenting no sharp angles to injure hose in contact with it. It will pass through a smaller hole than a screw coupling of the same bore.

The male of one coupling has been dragged at a fast trot behind a City passenger car (twice) for four squares, bumping over the cobble stones, and its appearance shows the hard usage it has been subjected to; yet it is water-tight and serviceable yet. This is a test which no other plan of coupling could endure without being ruined. It has been submitted to the ordeals of pressure, mud, falls, &c., and the result is that it has wearing qualities which cannot be exceeded.

A fire occurring in the upper part of a factory, owing to the operatives not understanding how to connect the screw couplings of the hose, got so much headway that $75,000 worth of property was destroyed; children, under the age of five years, after a few minutes instruction, have coupled a larger sized hose coupling than is necessary for buildings. The tremor on railroads will loosen any form of screw coupling after it has been a short time in use, and sometimes a loss of water in the tank is the consequence. The improved self-acting coupling incurs no risk of this kind, and is more quickly connected or disconnected.

All are familiar with the perplexity of servants in coupling and uncoupling the wash-pave hose, and the leaky joints from the loss of the ashers, or injury to the end of the male; the improved coupling has loose parts to get lost or to be injured by the usual wear. Their st will be about the same as the screw. The inventor, after many periments, brings forward this new joint, and it will be still further ted by a Committee of the Institute.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on R. H. Long's Salinometer Case.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"An Improved Marine Salinometer Case for Steam Boilers," invented by R. H. Long, of Philadelphia, Pennsylvania,

REPORT:—That the ordinary Salinometer Case, consists simply of a tube communicating with the boiler, and containing the hydrometer —the communication with the boiler being made by means of a pipe which passes from the bottom of the case to below the lowest water-level of the boiler, and provided with a stop-cock, which, when turned, permits the pressure of steam in the boiler to force the water up in the case, and float the hydrometer. But the ebullition in the case, produced by the escape of the steam under a reduced pressure, throws a great deal of hot water out of the instrument, and subjects the observer to the danger of being scalded, and at the same time causes such violent oscillations as to risk the safety of the hydrometer, and prevent its being read until the stop-cock is closed, when very frequently there will not be found enough water in the instrument to float the hydrometer.— The annoyances and tediousness of the instrument as ordinarily constructed, therefore, offer strong inducements to the persons charged with the care of the engine, to neglect the duty of reading it. The improvement of Mr. Long (which is well shown in the appended description) consists in adding to the ordinary Salinometer Case another tube connected with it at the bottom. This supply-tube is connected with the boiler by means of a pipe which passes from below the water-line of the boiler through the bottom and along the axis of the supply-tube to a point near its top, where it opens into the supply-tube by means of a number of vertical slits. The main tube, in which the hydrometer floats, is not connected with the boiler, but has a waste-pipe by which any escape of water may be carried off; and proper supports for a thermometer.

Now when, by turning the stop-cock, the water is forced from the boiler into the supply tube, it is thrown, not upwards, but against the side of the tube, owing to the mode of its escape. The steam which accompanies it, is separated and escapes through openings in the cover, and the water falling to the bottom passes through the tube of communication and rises to the same level in the Salinometer tube, in which, the hydrometer floats tranquilly, and may therefore be read speedily and accurately. By means of the waste-pipe, a current may be kept passing through the instrument, which is thus always in action, and may be read by the engineer at a glance, as he passes in the performance of his other duties.

The Committee believe the modification thus proposed, to be a simple and effective mode of inducing a more general and punctual use of

this valuable gauge, which ought not to be neglected on any boilers using salt water; and they therefore commend it to the notice of all engaged in the manufacture and management of such boilers.

By order of the Committee,

Philadelphia, January 12, 1860. WM. HAMILTON, *Actuary.*

Description by the Inventor.

This improvement consists in attaching the cylinder A to the cylinder B, having a communication C, as a means of safety to the hydrometer, perfect accuracy in testing the density of water, and insuring the engineer against danger from scalding, &c.

The cylinder or other shaped vessel A, is connected with the boiler by the pipe and stop-cock G, the pipe G being closed at the top and having openings on the side near the top, E E.

The water coming from the boiler and passing the stop-cock G, makes its exit through the openings E E: at this point the steam is liberated from the water and escapes through the openings f f. The water falls into the cylinder A, passes through the opening C, and rises to the water level S S S S in both cylinders; D is an overflow pipe to carry off the surplus water, and to keep up a sufficient current to maintain the water to be tested, at the required temperature. By turning the stop-cock H, both cylinders can be discharged. T is a thermometer fitting in a slide. X is the hydrometer. K is the cover for closing the case when not in use. I is a bracket for securing the instrument to the boiler, bulkhead, or other suitable place.

This instrument affords a ready means of drawing water from a steam boiler under any pressure and temperature, without ebullition in the cylinder B or oscillation to the hydrometer.

The Scientific American.

Hon. Judge Mason, of Iowa, who made himself so popular with the inventors of the country while he held the office of Commissioner of Patents, has, we learn, associated himself with Munn & Co., at the *Scientific American* Office, New York.

Abstract of Meteorological Observations for November, 1859; made in Philadelphia, Adams, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1859.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 feet. Prof. M. JACOBS, Obs.						SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.							
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.	Barometer.		Thermom.		Rain and Snow.	Prevail'g winds.	Barometer.		Thermom.		Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.
Nov.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.	Mean.	Mean daily range.			Mean.	Mean daily range.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	Inch.	°	°	Inch.	Direc.	Inch.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	30·017	·081	43·0	19	1·3	·129	87		(var.)	29·705	·009	33·8	8·7		S W.	27·771	·037	34·3	0·3	·191	61		?
☽ 2	29·976	·035	43·7	23¼	2·0	·170	42		WSW.	29·650	·070	38·3	4·5		S W.	27·788	·043	37·0	2·7	·188	56		W.
3	30·247	·271	46·7	20	2·0	·180	43		W.	29·913	·263	40·0	1·7		N W.	27·978	·190	42·0	5·0	·242	56		W.
4	30·147	·121	51·7	24	6·0	·255	46		S W.	29·801	·112	46·0	6·0		S W.	27·916	·062	50·7	12·0	·397	56		S W.
5	30·031	·126	56·2	26	4·5	·333	49		S W.	29·677	·124	54·0	8·0		S W.	27·834	·049	59·3	6·0	·348	51		W.
6	30·232	·211	48·8	18	7·3	·147	32		N E.	29·923	·249	44·7	9·3		N E.	27·986	·119	48·3	11·0	·209	44		E.
7	30·295	·063	48·0	21	2·5	·202	42		N E.	29·970	·047	42·0	4·0		(var.)	27·972	·024	42·7	5·7	·216	61		S E.
8	30·178	·117	52·8	18	4.8	·309	60		N E.	29·872	·098	46·7	5·8		N E	27·875	·097	50·8	7·7	·296	55		S.
9	29·985	·194	52·8	18	2·7	·380	76		N E.	29·612	·260	58·3	6·0		S W.	27·692	·183	55·0	4·7	·393	59		S E.
○ 10	29·634	·360	58·5	12	5·7	·478	88	0·025	S.	29·167	·425	58·3	5·0		S.	27·371	·321	52·0	3·0	·307	71	0·009	W.
11	29·785	·197	48·2	21	10·3	·170	42		N W.	29·443	·256	43·0	15·3		N W.	27·575	·204	40·7	11·3	204	68		(var.)
12	29·806	·179	51·7	24	9·8	·327	74		S E.	29·367	·168	42·7	5·0	0·110	S E.	27·376	·199	53·7	13·0	·295	59	0·017	S.
13	29·532	·274	44·8	31	20 5	·226	83	0·868	N W.	29·143	·279	38·0	16·7		(var.)	27·367	·117	24·0	29·7	·074	60	0·151	W.
14	29·951	·419	33 7	13	12·5	·123	54		(var.)	29·579	·469	29·0	13·7		(var.)	27·673	·305	28·3	15·7	·134	69		W.
15	30·131	·180	40·3	20	6·7	·142	42		N E.	29·719	·187	31·3	5·7		(var.)	27·792	·119	34·0	9·0	·225	79		S W.
16	30·208	·077	45·3	23	5·0	·242	56		N E.	29·841	·092	35·7	4·8		S W.	27·861	·072	45·3	4·7	·183	47		S.
☾ 17	30·167	·040	51·0	22	5·7	·351	70	0·015	N E.	29·804	·087	47·7	12·0		S W.	27·848	013	47·3	8·7	·295	59		S.
18	29·856	·312	56·7	14	5·7	·487	94	} 1·286	N E.	29·439	·365	52·0	7·7	0·280	N E.	27·583	·266	52·0	9·3	·334	86	0·258	E.
19	29·513	·343	61·0	12	6·7	·325	67		S W.	29·051	·388	56·7	8·0		(var.)	27·272	·316	45·0	7·0	·262	84	0·146	WSW.
20	29·913	·400	46·2	18	14·8	·183	47		WSW.	29·597	·545	41·7	15·0		N W.	27·730	·458	36·0	9·0	·142	51		(var.)
21	30·090	·216	40·0	14	8·8	·190	74	1·578	N E.	29·720	·226	35·8	6·8	0·790	(var.)	27·692	·082	36·0	6·7	·176	85	0·626	S E.
22	29·804	·287	52·2	16	12·2	·308	64		W.	29·449	·269	46·7	11·3		S W.	27·589	·120	46·0	10·0	·244	60		W.
23	29·949	·146	47·3	11	4·8	·172	46		W.	29·627	·167	44·3	8·0		N W.	27 817	·228	38·0	8·0	·152	64		W.
● 24	30·201	·252	36·0	15	11·3	·130	55		N W.	29·868	·251	37·0	7·3		(var.)	27·951	·134	34·3	5·0	·153	61		N W.
25	30·143	·095	36·8	13	4·2	·138	56	0·017	(var.)	29·782	·169	31·0	8·0	0·015	S.	27·698	·253	33·7	5·8	·147	78	0·056	S.
26	29·681	·462	54·2	27¼	17·3	·342	57		W.	29·290	·442	50·3	19·3		N W.	27·490	·239	46·3	12·7	·219	54		W.
27	29·785	·105	45·5	11	8·7	·140	40		W.	29·366	·136	41·3	9·3		N E.	27·625	·085	37·0	9·3	·179	64		W.
28	29·804	·080	43·0	13	3·2	·162	45		WNW.	29·420	·102	38·0	3·3		(var.)	27·561	·084	33·7	3·3	·155	58		W.
29	29·973	·169	40·0	16	3·0	·146	47		W.	29·578	·156	36·3	1·7		S W.	27·684	·123	33·0	5·3	·172	60		S W.
30	29·932	·041	49·7	21¼	9·7	·261	63	0·008	S W.	29·553	·039	37·7	2·0		(var.)	27·657	·027	51·3	18·3	·281	58		WSW.
Means	29·965	·193	47·5	18¼	7·3	·241	56	3·796	N55°W.	29·597	·211	42·4	7·6	1·195	S78°W.	27·697	·152	42·2	8·6	·229	62	1·258	S44°W.

Abstract of Meteorological Observations for November, 1859; *made in Dauphin, Northumberland, Centre, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

1859.	Harrisburg, Dauphin Co. 40° 16′, N. 76° 15′, W. Height, 300 feet. John Heisely, M. D., Observer.						Shamokin, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs.			
	Barometer.		Thermom.		Rain and Snow.	Pre-vail'g winds.	Thermom.		Rain and Snow.	Pre-vail'g winds.
Nov.	Mean.	Mean daily range.	Mean.	Mean daily range.			Mean.	Mean daily range.		
	Inch.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.
1	29·949	·009	40·7	3·3		W.	35·0			W.
☽ 2	29·920	·040	44·3	3·7		W.	35·7	7·3		W.
3	30·191	·271	44·7	1·0		N W.	37·7	2·3		W.
4	30·065	·125	51·0	3·3		S.	49·3	10·7		E.
5	29·950	·116	55·3	5·0		S W.	51·3	7·3		W.
6	30·194	·244	49·3	8·0		N.	40·7	11·3		W.
7	30·248	·054	44·7	4·7		S E.	35·3	5·3		(var.)
8	30·140	·108	49·3	5·3		E.	46·0	13·3		S.
9	29·890	·250	53·7	4·3		N E.	52·0	8·7		W.
○ 10	29·472	·417	58·7	5·0		S W.	59·3	7·3		W.
11	29·715	·243	48·3	10·3		N W.	41·3	18·0		W.
12	29·661	·186	47·3	6·3		E.	42·7	8·0	0·175	(var.)
13	29·408	·267	43·3	17·3		N W.	40·7	19·3	0·100	W.
14	29·888	·480	37·0	14·3		N W.	28·0	12·7		W.
15	30·043	·156	36·3	4·0		E.	33·3	8·0		W.
16	30·141	·097	40·3	4·0		E.	35·3	12·0		S.
☾ 17	30·098	·042	50·7	10·3		S E.	50·0	14·7		S.
18	29·750	·348	55·7	5·0	} 0·314	E.	56·0	6·0	0·280	S.
19	29·822	·428	58·7	6·0		(var.)	57·8	4·0	0·943	W.
20	29·864	·542	47·0	11·7		N W.	42·7	14·7		(var.)
21					} 0·730	E.	33·3	9·3	0·810	S E.
22	29·717		47·7			W.	46·0	12·7		W.
23	29·899	·181	47·7	1·3		N W.	44·7	1·3		W.
● 24	30·135	·236	41·3	6·3		N W.	34·0	10·7		W.
25	30·008	·152	35·8	6·7		S E.	30·0	5·3	0·151	S.
26	29·543	·464	50·7	15·3		W.	45·3	15·3		W.
27						(var.)	37·8	10·7		(var.)
28	29·703		42·3			W.	42·0	4·7		W.
29	29·875	·173	40·3	2·0		S W.	34·3	7·3		(var.)
30	29·840	·036	43·0	2·7		S E.	42·7	8·0		(var.)
Means	29·879	·218	46·6	6·4	1·044	N 68½ W	42·0	9·5	2·459	S 54½ W.

1859.	Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs.				Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.				Tarentum, Allegheny Co. 40° 37′ N. 79° 46′ W. Height 950 feet. J. H. Baird, Obs.		
	Thermom.		Rain and Snow.	Prevail-ing winds.	Thermom.		Rain and Snow.	Pre-vail'g winds.	Thermometer.		Prevail-ing winds.
Nov.	Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	37·7	1·3		(var.)	34·0	1·3		S W.	33·0	5·3	S W.
☽ 2	38·0	6·3		N W.	37·0	5·7		S W.	36·0	4·3	W.
3	38·7	5·3		(var.)	42·3	5·3		S .	39·0	3·0	W.
4	45·7	7·0		N W.	54·7	12·3		S.	49·7	9·7	S W.
5	56·3	10·7		N W.	58·3	5·0		S.	56·7	7·0	(var.)
6	37·7	18·7		S E.	45·7	12·7		E.	46·3	10·3	N.
7	36·3	2·7		W.	47·0	4·0		S E.	44·3	2·0	E.
8	43·3	12·0		W.	53·7	6·7		S E.	46·3	2·7	N.
9	51·3	7·7		W.	53·7	2·0		S E.	46·7	4·3	N W.
○ 10	56·3	5·7		S W.	51·3	5·0		(var.)	47·7	7·0	S W.
11	38·7	17·7		W.	40·3	11·0		N W.	39·3	8·3	N W.
12	41·0	6·3	0·842	S E.	52·3	12·0	0·650	(var.)	46·3	7·0	(var.)
13	33·7	14·0	0·213	N W.	23·3	25·7	0·210	S W.	27·3	19·0	(var.)
14	27·0	10·0		N W.	25·0	9·0		S W.	27·0	4·3	(var.)
15	29·3	5·7		(var.)	33·7	9·3		S W.	34·3	7·3	W.
16	31·7	5·0		S E.	42·3	9·3		S E.	39·3	10·3	(var.)
☾ 17	41·0	9·3		W.	47·0	4·7		S E.	41·0	3·0	(var.)
18	51·7	10·7	} 0·510	E.	56·7	9·7		S E.	52·0	11·0	(var.)
19	53·0	12·0		(var.)	47·7	11·0	0·350	S W.	47·7	14·3	S W.
20	37·3	15·7		N W.	36·3	11·3		(var.)	37·3	10·3	N W.
21	37·3	5·3	0·720	E.	38·7	5·7	0·590	S E.	41·7	8·3	S E.
22	44·3	7·0		W.	46·0	8·0		(var.)	46·7	6·0	S W.
23	40·7	5·0		W.	38·0	8·0		W N W	40·3	6·3	S W.
● 24	35·0	5·7		N W.	33·3	6·0		N.	34·3	6·0	N W.
25	29·7	12·0	0·140	S E.	37·0	5·7	0·040	S E.	42·7	11·7	(var.)
26	50·0	20·3		N W.	44·0	8·3		S W.	45·7	13·7	S W.
27	37·0	18·0		(var.)	35·3	8·7		S W.	35·3	10·3	?
28	34·0	9·0		W.	33·3	2·7		W.	30·7	4·7	(var.)
29	32·7	6·7		S W.	30·7	3·3		(var.)	30·3	3·7	(var.)
30	39·3	6·7		S W.	47·3	16·7		S S W.	47·0	16·7	(var.)
Means	40·4	9·2	2·425	West.	42·2	8·2	1·840	S 19° W.	41·1	7·9	S. 80½° W.

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CIVIL ENGINEERING.

Translated for the Journal of the Franklin Institute.

The Sewerage of Algiers. By M. PIARRON DE MONDESIR, Eng. (*des Ponts et Chaussées.*)

INTRODUCTION.

In presenting a description of the drainage works of Algiers for publication in the "*Annales des Ponts et Chaussées,*" I thought it might be favorably received by the administration of Public Works, who cannot fail to take a lively interest in the work done in Algiers by the engineers whom they have sent to this colony.

I supposed, moreover, that this account might be read with some interest by the Engineers of the Corps, not so much on account of the importance of the works, (for France, and Paris especially, has the same kind on a much larger scale,) as that they were executed in a country but little known, and upon whose progress France keeps a watchful eye.

Alignement.—The sewerage of the enclosure of Algiers was designed and executed principally for the purpose of freeing the harbor from the foul products of the drains of the city. A summit level canal is substituted for the ancient canals, which, lying perpendicular to the shore, and emptying directly into the harbor, occasioned more or less injury; while it answers as a substitute, it, at the same time, insures a healthful condition of the city.

On an inspection of the Plan of Algiers, (Pl. I, Fig. 1.) it will be

seen that a surface of 360·6 acres, comprised between the new fortifications, is composed of two principal basins separated by the line A B C, to wit:

Basin north of summit ridge, A B C, whose sewers discharge outside of the harbor,		103·7 acres.
The south basin, whose sewers emptied directly into the harbor before the construction of the canal,		256·9 "
	Total,	360·6 "

The harbor receives also the products of the outer basin of the Tivoli Ravine, which passes under the fortification, and traverses the Faubourg Bab-Azoun; the surface of this outer basin is 54·3 acres.

The main object was to free the harbor from the products of a total surface of 311·2 acres, and to attain this end, three principal branches were designed and executed; these combined, constitute the drainage of the enclosure of Algiers.

These three branches have their origin at the government square. The first, that of the Marine, follows the street bearing its name throughout its length, passes under the gate of France, and empties outside the harbor, west of the Jetty Cheriddin.

The second, that of Bab-el-Oued, follows the street of its name throughout its length, and empties into the sea back of "Fort Neuf" to the west of the Marine Branch, and, consequently, outside the harbor.

The third, that of Bab-Azoun, follows, throughout their length, the streets Bab-Azoun, and of the Faubourg Bab-Azoun, and discharges into the sea outside the South Jetty now in construction.

The length of these three branches, is

Branch of the Marine,		1033 feet.
" " Bab-el-Oued,		1945 "
" " Bab-Azoun,		4944 "
	Total,	7922 "

The basin of the Marine Branch comprises an area of		14·8 acres.
That of the branch Bab-el-Oued, " "		83·9 "
" " Bab-Azoun, " "		279·1 "
	Total,	377·8 "

At the present time there remains but a surface of 37 acres, whose product is delivered directly outside of the harbor. The product of 69 acres is now delivered into the branch Bab-el-Oued.

It is apparent that the branch Bab-Azoun is, by far, the most important in respect to its length and extent of basin.

Sewerage established according to the Free System.

Before continuing this description, it is proper to state, that the sewerage of Algiers is designed, as those of London and other cities in England, to carry away, not only the rain and house waters, but also all the stercoraceous matter of the city, and it is, moreover, to have placed within the galleries, upon cast iron brackets, pipes for the distribution of the water to the lower parts of the city. These dispositions

contemplated in the project have occasioned objections on the part of the General Council of "Ponts et Chaussées."

Discussion of the "Free System."

Questions bearing closely upon the public health, afford a peculiar interest, and I thought it would be well to present a summary of the objections made by the Council General of "Ponts et Chaussées," and to state the reasons which determined the War Department to uphold the intention of the project.

The Council General of "Ponts et Chaussées" have declared against a system which involves the reception of stercoraceous matter into the public sewers, a system which we shall hereafter briefly designate as the free system. Its inconveniences were pointed out in the report of M. Inspector Darcy,* the main features of which were

On the one hand, that it occasions deleterious effluvia, existing constantly in the sewers, which escape through the water inlets, and some of the pipes, and so compromise the public health; and, on the other hand, it is held to be a voluntary deprivation of a source of very precious compost.

In support of this opinion the report cites the inconvenience experienced in London, Brussels, and Liege, and the opinions of divers English and Belgian engineers upon this subject.

The General Council would not approve of placing conduit pipes in the interior of a sewer established under such conditions, that is to say, *in a canal designed to become the general privy of the city of Algiers, a hot-bed of infection which could not be traversed without danger.*

He concludes that none but the rain and house waters should be admitted into the sewers, and that the perfected processes for clearing night soil, practised in Paris, should be applied to Algiers. This, it appears, was to place the city of Algiers in the condition of Paris, and other great cities of France, in the matter of sanatory works.

Not only would these novel dispositions change the whole economy of the projects of the sewerage, but their application would have completely destroyed the usages which existed in Algiers long before the conquest. In fact, excepting some new streets of the Faubourg Bab-Azoun, every street and every alley is furnished with a public sewer, which receives the night soil of the neighboring houses. The prohibition of the entry of these matters, is the prohibition of any sewer in the city, since the sewer of the enclosures receives nearly all of them.

It would then be necessary to construct vaults under all the houses, and to prevent their communication with the public sewer.

Without speaking of the administrative and practical difficulties attending the application of this measure, it might be reasonably objected that the majority of the streets being impassable for carriages, the application of the processes adopted in Paris, however perfected elsewhere, would become here, an impossibility.

*The honorable M. Darcy will pardon me for publishing here his personal opinion upon a question so much agitated as to become the order of the day. But, in citing the different opinions of distinguished engineers, I could not pass in silence the remarkable report of M. Darcy, a report approved by the rest of the Council General "des Ponts et Chaussées."

On the other hand, it may be asked whether the cisterns which are under nearly all the houses in Algiers to receive the terrace rain water, and whose utility is unquestioned, would not suffer from their vicinity with the vaults.

Finally, looking upon Algiers, built like an amphitheatre, upon the borders of a sea uninfluenced by tides, we may ask if it were not rational to take advantage of its topography to carry off, at once, all the impurities of the city,

The local administration might itself appreciate the inconveniences of the sewers of Algiers, and thus, to a certain point, take account of the future situation of the enclosure sewer by comparing it with many new sewers of large section, already constructed in Consuls, Duquesne, Charte streets, &c.

It is proved that these new sewers, which date four or five years back, have undergone no repairs or cleansings since being put into service, and that they have worked perfectly. There is a total, or nearly total, absence of impurities, or of deposits, and the linings are in a good state of preservation, &c.

The impurities flow without difficulty, the sewer men and employees pass through the galleries without being incommoded by the smell. The smell is sensibly the same for all the sewers of Algiers, where ammonia slightly prevails, and not the least trace of sulphuretted hydrogen can be distinguished.

These observations were of a character to satisfy the local administration as to the future inconveniences of the sewer of the enclosure.

I would observe that these facts agree with the observations of M. Mougey, engineer, (whose loss is so much regretted by the corps,) upon the London sewers. In his Memoir upon this subject may be found the following lines:—

"Notwithstanding the irregularity of the service, and the cleaning of the London sewers, all those which, under the authority of the Westminster and Finsbury commissions, I was permitted to visit, seemed to be in very good condition; the masonry, always of brick, is remarkably well executed, the current of air is quite strong, and hardly a perceptible smell." *

The administration is well assured that, by taking certain precautions, whether for the ventilation of the galleries, or against the emanations through the water inlets, or for the cleaning, on a large scale, of the galleries by means of slushing; precautions, moreover, recommended in the report of M. Darcy, all the inconveniences signalized by the Council of "Ponts et Chaussées" have disappeared, and that there is nothing that should prevent the use of the three branches of the enclosure sewer, and the placing of water conduit pipes in them. The opinions of the Council still admitted a certain reservation.† This leaves some margin for the definite solution of an important question on which there is so great a difference of opinion.

* Annales des Ponts et Chaussées, Tome xxiii, 1838, p. 170.

† The honorable M. Darcy says, in his Report, "It is to be understood that I advance these opinions with a certain reservation; for it is always difficult to appreciate when not upon the spot, the considerations which may have guided the local authorities."

Experience has demonstrated, since the putting in service of the three branches of the sewer, that the dreaded inconveniences do not appear. Our workmen now pass through the galleries as easily as if there was only a stream of clear water. I, myself, have gone through many times without being incommoded. I only observed the prevalence of ammonia. Many interior complementary works, such as lining, pointing, cleansing, &c., have been executed since the service of sundry portions of the sewer. I affirm that the workmen labor all day without objecting or suffering the least indisposition. It is now settled that the galleries may be visited without the least danger, and that, without inconvenience, the water pipes may be laid upon the brackets, all ready to receive them.

I will, at another time, speak of the measures adopted to avoid the inconveniences of exterior emanations.

I may now be permitted to draw a parallel between the situation of the Algiers Sewer, and that of the sewers of London, Brussels, and Liege, which the honorable M. Darcy has cited in his reports as examples against the free system.

Must the inconveniences produced in these three cities, by the admission of soil matter in the public sewers, of necessity be produced in Algiers? I answer unhesitatingly, No, for their conditions are not the same.

In London, the sewers empty into the Thames, which in turn flows back on the flood tide. It often happens that in high tides the interior inundations, passing up through certain conduits, enter the cellars of the houses.

Another inconvenience of the London sewers arises from the slight inclination at several points. But the gravest of all is the deterioration of the waters of the Thames, which supplies the largest part of the water drunk in London.

This fact is proved in the Memoir of M. Mougey already quoted, and in that of M. Mille, entitled, "*Assainissement des Villes en Angleterre.*"*

None of these inconveniences can be experienced in Algiers. There are no perceptible tides, and the slopes of the sewers are much inclined, the smallest being 0·01 ft. per foot.

The report of M. Darcy tells us what occurs at Brussels. Notwithstanding the express prohibition contained in all the ancient and recent laws, of the construction of privies without inclosed cesspools; and by reason of the unaccountable toleration of this evil, there are so many houses which have put their vaults in communication with the public sewers, that they now refuse to redress the evil.

Thus, fetid and unwholesome exhalations escape from the sewers, chiefly in the low parts of the city, where the deposits accumulate.

M. Verslays, inspector of the sewers of Brussels, impressed with these inconveniences, does not hesitate to declare against the free system.

This is undoubtedly a serious matter; but it is a *forced* application

* Annales des Ponts et Chaussées, Mars et Avril, 1856.

of a system probably unsuited to the topography of Brussels, and against which no proper precautions seem to have been taken. This example proves nothing against the application of the free system under other circumstances.

The example of the city of Liege, where serious accidents have occurred in consequence of the presence of night soil in the public sewers, might prove to be a condemnation of the free system, if these accidents were not attributable to purely local causes.

A report of the medical commission of Liege asserts, that in the time of high water, the Meuse penetrates the sewers of the city, as the Thames in London; that the well water then is vitiated by the filtrations of the sewers, and that serious accidents have befallen those who used the water; all of which was attributed to the presence of sulphuretted hydrogen dissolved in the water.

These accidents the reports inform us, "*occurred chiefly in the lower* "*portions of the city, especially in those where the sewers are badly* "*constructed, or defective from decay; since, in this case, the water* "*from the sewers filtrates in great abundance.*"

It appears that the accidents are attributable to two local causes: the inundations of the Meuse, and the bad state of the sewers.

As to the presence of sulphuretted hydrogen dissolved in water, this would be a general cause of insalubrity, and might be a powerful argument against the free system.

We would first observe that the accidents recorded at Liege resulted from the consumption of water infected with sulphuretted hydrogen, and not from inhaling the deleterious gas.

Water can dissolve at the ordinary temperature and pressure of the atmosphere about three times its volume of this gas, and therefore in receiving night soil, the sulphuretted hydrogen can only exist in a state of solution, and never in that of gas, if the sewer only receives a certain quantity of water.

The calculation of this quantity can be approximately made for any sewer, by means of certain chemical data, in keeping an account of the population of the houses communicating with the sewers.

During the summer, the City of Algiers only receives from the aqueducts which supply it, 13·2 Imperial gallons per head, in twenty-four hours,*; and, as there is no rain there, the sewers can only receive the waste of this 13·2 gallons. This quantity of water, far inferior to that passing through the sewers of London, is still enough to dissolve all the sulphuretted hydrogen, since this gas has never caused the least accident in the sewers of Algiers, even during the hottest weather.

Blidah, another town of Algeria, enjoys the free system, to the great advantage of the population and of agriculture.

The sewers are supplied daily with an enormous quantity of water as compared with the importance of this little town (706,820 cubic feet every twenty-four hours), which is derived from the Oned-el-Kebir, and discharges from the heads of the sewer to serve in irrigating the neighboring fields.

* This quantity will reach 22 gallons on the completion of the projected works.

The sewers of Blidah having a considerable slope, there is nothing to be desired, in a sanatory point of view; while its magnificent gardens are nourished with water having in solution the principles of a valuable compost.

While in England the free system is growing more in favor, and advancing more towards perfection; and, while it is successfully applied in Algiers, there is in Belgium a strong opposition to its inconveniences.

The opinions upon this subject are still divided. In waiting for a definite solution of this question, I could not pass in silence the opinion of M. Mille, so decidedly advanced in his interesting report already quoted. He is the great partizan of the free system, and proposes its application in Paris.

It is certain that the suppression of the vaults would be an advance in a sanatory point of view; but, on the other hand, the introduction of soil into the sewers, would be attended with evils more or less serious according to the localities, and would frequently exact important works.

That a city may enjoy the free system without inconveniences, it is necessary,

1st. That it should establish sewers in all the streets.

2d. That it should have a distribution of water sufficient to dissolve all the sulphuretted hydrogen gas, and to cleanse the sewers.

3d. That it should have the means of disposing of the contents of the sewers without hazarding the public health.

It is not easy in all cases to fulfil these three conditions, and in many cities it would call for immense works.

In Paris, for example, should the first two conditions be fulfilled in part, the third would involve a large expense, whether for the construction of lateral sewers in the Seine, or for the establishment of some contrivance for the removal of organic matter, which could not be emptied into the river without endangering the public health, and which, moreover, should not be lost, being so valuable as a compost.

An idea of these works may be gathered from the vast project of John Martin, described in the article of M. Mougey upon the London Sewers, and from that of M. Forster, described in the Memoir of M. Mille. This vast project would not cost under forty million francs.

It is hard to decide upon so difficult a question. It appears to be impossible to establish general rules, and we should apply in each city processes which are found to be best adapted to its topographical situation.

Before closing, I would say a word upon the question of compost arising from the organic matter of the sewers, which appears to have been completely sacrificed at Algiers in the construction of the enclosure sewer.

No plan has as yet been proposed for gathering this fertilizing matter, which is now lost in the sea. It is not because the question has not come up before the local administration, but it did not seem well

for them to take the initiative of its application to agriculture, especially in a fertile country where manure is of less value than in France or England.

Still, if any of the industrial departments should offer to apply to agriculture the fertilizing principles contained in the sewers, it would be easy to establish at the lower ends of the three branches, wells or reservoirs, in which might be deposited organic matter, mud, &c., leaving the liquids to be decanted in the sea.

Thus far no offer of the kind has been made.

I now continue the description of the principal plans of the enclosure sewer.

The Marine Branch—The marine branch has a total length of 1033 feet, with slopes varying from ·01 ft. to ·35 ft. per foot, independently of a fall of 10·89 ft. near the lower end, and of an inclined plane with a vertical height of 6·16 ft. (Fig. 2, Pl. II.)

This fall was occasioned by the passage under an arched magazine of the military engineers. As to the inclined plane, which was not provided for in the plan, it was made to increase the depth of material under the gate of France, as well as to facilitate the construction of a tunnel, as it was not allowed to pass with an open cut.

This branch presents two principal sections, represented Pl. I., Figs. 2 and 4. Upon an intermediate length of 98 feet, the sewer has the singular form represented Pl. I, Fig. 3, an explanation of which will be given hereafter.

These sections were calculated, not so much for the draining of the 14·8 acres, as for the necessities of the interior service, visiting, cleansing, placing, and maintenance of the conduit pipes set upon the brackets.

The singular form of Fig. 3, is due to the presence of a particular portion of the sewer constructed by our service in 1846, for the provisional sewerage of the street Duquesne, with the view of ultimately becoming an integral part of the enclosure sewer. The recess seen upon the right hand side wall, was designed to support a conduit pipe. As in 1846, the definite study of the plan was not matured, an approximate level was adopted for this part, which was afterwards found to be 3·28 feet too high, on consideration of the conditions of level imposed by the branches of the sewer of the street Trois-Couleurs.

Instead of demolishing this portion of the sewer, whose masonry was excellent, it was thought best to preserve it by underpinning, and destroying only the invert, and connecting the old and new piers. This explains why the section has a height of more than 9·8 feet under the key, for a width of only 2·29 feet.

The branch of the Marine, is furnished with four man-holes, with cast iron circular ring frames and covers, for the entrance to the galleries, and nine water inlets.

The junction of all the public and private drains of this quarter, with the principal canal, is effected by a development of secondary canals attaining a length of 1158 feet, or 124 feet more than that of the principal canal.

The sewer along the left side, follows the upper side of the street of the Marine, which is constructed with arcades. The axis of the sewer is aligned 6·5 feet from the plane of the facade of the arches.

From this, branch out twenty-six private drains for the houses of the street of the Marine. The gutters, in number twenty-five, leading into the public way the terrace waters, have also been put in communication with the sewers.* This was the case also for four public urinals.

The alignement of the sewer upon the upper side of the street in preference to the centre, was adopted for two reasons: 1st. To diminish the length of the public branch sewers. 2d. To incommode as little as possible, the passing of vehicles during the execution of the work, in a street only 26·24 feet wide.

But this disposition was rather dangerous for the neighboring houses, (which are generally built on light foundations), as the level of excavation was, most generally, below that of the foundations of the pillars of the arcade. Great precautions were then needed, for taking care of the houses during the construction of the sewer. Not only were the excavations solidly shored, but a still more prudent measure was taken, that of tunneling certain portions, several feet in length. These small tunnels, which are seen in the longitudinal profile in which the sewer was constructed, served the purpose of a strong buttress for the pillars of the arcade. This method was especially adopted at the angles which were naturally the most exposed; in this way, every accident was avoided.

Another difficulty occurred at the passage of the gate-way of France, which has two openings, one for carriages, the other for foot-passengers; the alignement passed under the first. An open cut would have completely interrupted their passage, unless an enlargement was effected in the foot-way gate.

The active circulation of carriages at this point, would not admit of our stopping the only passable outlet between the city and the port. On the other hand, the military engineers were opposed to the enlargement of the little gate.

It became necessary to accomplish this passage by a tunnel, and for this reason, the above mentioned inclined plane was made, which admitted of a covering of about 7·5 feet of earth above the extrados of the arch.

This work presented some difficulties. The earth under the gateway was made-earth. Every passing carriage occasioned a fall of pieces from the top of the tunnel, upon the heads of the workmen. Thus the work was carried on, a yard at a time, the masonry in cement keeping pace with the advance, which was maintained night and day without interruption.

Branch Bab-el-Oued.—Its whole length is 1945 feet. The slope is 0·0122 feet per foot upon the first 1476 feet. In the longitudinal profile, (Pl. II, Fig. 1), a fall of 12·1 ft. is seen, then a slope of 0·028 ft.

* From what has been said as to the existence of cisterns under nearly all the houses of Algiers, we might be surprised at the number of gutters which waste the terrace waters upon the public way, instead of storing it in the cisterns. This is due to the fact, that the houses are of French build. Every Moorish house is invariably furnished with a cistern, which, notwithstanding the obligatory decrees, is the case with but few of the French houses.

per foot to the facade of Fort Neuf upon the sea, then an inclined plane of 0·151 ft. per foot in its passage through the shore.

The fall was a necessity arising from the passage of the deep fosse along Fort Neuf.

As to the inclined plane of the shore, that was an after work. The outlet of the Branch Bab-el-Oued was, at first, established on the alignement of the enclosing wall of Fort Neuf at 13·12 feet above the level of the sea. But as, at certain periods, the impurities gathered upon the shore into an infected pool, the sewer was prolonged to avoid this inconvenience.

The new outlet was fitted into a large rock, and the impurities are delivered immediately into the sea.

The branch Bab-el-Oued presents three different sections with widths of 3·93 ft., 4·26 ft., and 4·92 ft.; and with heights under the key of 5·57 ft., and 5·74 ft. (Pl. I, Figs. 5 and 6.)

These sections are more than sufficient to deliver the product of the heaviest showers, since, according to the most liberal calculations, the water cannot rise over 1·64 ft. at the extremity of the first slope.* But, account was taken here, as in the branch of the marine, of the wants of the exterior service, and especially of the presence of two conduit pipes in the portion 4·92 ft. wide.

The branch Bab-el-Oued is provided with five man-holes and sixteen water-inlets. The secondary canals attain a development of 1220 ft. There are nineteen private drains, twenty-one gutters, and three urinals emptying in it.

The street Bab-el-Oued has arcades the same as the street of the Marine. To protect the houses, the same measures were taken as in that street. They are now more stable from the presence of the enclosure sewer at the foot of their foundations. The construction of the branch Bab-el-Oued met with some difficulties, though none very serious.

The first was in crossing Askew the street Bab-el-Oued, with depths of 23 to 26 feet. This was made by a tunnel for a length of 115 feet, and was in all respects well executed, notwithstanding the layers of made earth, and the curved alignement of the sewer. The tunnel was made in small portions at a time, taking care that the masonry should keep pace with it.

The junction of the sewer of the street of Casbah, the construction of a man-hole and two water inlets at this point, which were made in the rainy season, with a depth of 16·4 feet, in the midst of other sewers, and in made ground diluted by the filtrations of the sewers, gave us trouble of which no just idea can be formed by the mere inspection of the apparently simple sections.

The excavation was near an ill-constructed house at the corners of the streets Bab-el-Oued and of Casbah, and caused us considerable anxiety.

* The basin of the branch Bab-el-Oued has 93·9 acres. The product of a storm yielding 0·64 ft. upon the surface, would produce in the section 4·92 ft. broad, above the fall a height of about 2·9 ft. water if the section above the fall received all this product. But, it must be borne in mind that about half the basin delivers its water immediately above the fall, by the culvert which traverses the route at this point.

The street Bab-el-Oued is a new street opened in the midst of a mass of Moorish houses, which have been taken down to be replaced by French arcades. We would naturally expect to find in such a quarter, ancient excavations, such as wells, cellars, and cisterns. One of these excavations, opposite Jémima street, extends two-thirds the width of the street. The heavy carts used for transporting the blocks for the Jetties of the port, threatened to crush the arch (of Terre mise) laid bare by the excavation for the sewer. This difficulty was remedied by the speedy construction of a sustaining wall built in the night, without which the passage of the street would have been wholly intercepted.

Notwithstanding these difficulties and the delays occasioned by them, the two branches of the Bab-el-Oued and of the Marine, which were commenced at the same time, in September, 1852, were finished in 1853. Eight months sufficed, notwithstanding the winter storms, to establish under ground 2978 feet of main canals, and 2378 feet of branch canals.

A portion of the sewers which polluted the port, especially that of the two fish sewers, was diverted.

Such was the first result of this work.

(To be Continued.)

Steam Engineering in 1859.* *Application of Steam as a Motive Power.*

(Continued from page 78.)

In the preceding paper contained in the August number, the attention of the engineering reader was directed to the prevalent defects in the conveyance of steam through the pipes and cylinders; and it must be confessed that among practical men the most lamentable ignorance exists, and for the simple reason, that the evils referred to are not immediately evident. The cylinder and the steam therein make up their own accounts, and very few take the trouble to investigate the balance.

A fall of three or four inches in the vacuum is sufficient to alarm the most indifferent engineer, but a loss of 30 per cent. by condensation is not worth consideration.

Does the use of superheated steam economize the fuel? The answer to this question must be in the affirmative; facts are stubborn things, and we have just now ample proof that the economy arising from superheating steam is a fact.

Then, whence does this great economy of 20 and 30 per cent. arise? Is there some new and mysterious property given to the steam in the process of superheating? or can the improvement resulting be accounted for in an ordinary and common-sense way? We believe it can.

The results arising from the use of superheated steam reflect severely and most justly on the positive ignorance of steam engineers. How is it that there is sufficient *waste* heat from the boiler furnace in the present boilers, to supply the additional heat to the steam? We excuse

* From the Lond. Artisan, Sept., 1859.

arrangement, and has been *one* of, if not *the* chief cause of so much more attention to the economy of expanded steam. The marine engineer must regard the link, as a reversing gear, almost with positive affection; so handy, so certain, and, at the same time, such a fair apology, as the times go, for an expansion gear.

But the link will not enable us to expand the steam six, seven, eight, and nine times.

Before the introduction of double-ported valves in marine engines, perhaps no cut-off could be more effectual than the additional slab slide on the back of the main slide, and worked by a separate eccentric, arranged with a segment to alter the expansion at pleasure; and this plan is increasingly adopted in land engines as simple and effective. We only mention it as a plan perhaps more generally approved than any other.

With the prospect of increased pressure and increased economy, a simple and effective expansion is a great desideratum. It is quite beyond the purpose of these remarks to do more than point out the want.

The naked truth is, that the mass of steam engines are *not* fitted with expansion gear, and the owners of such are spending a shilling where six pence would more than suffice; the old story.

The link motion is better adapted for locomotives than any other description of steam engine, but yet it does not fulfil the conditions necessary for the most profitable expansion of 150 lbs. steam.

Notwithstanding the convincing arguments of those who uphold that low pressure is more economical than high pressure steam, it is to be feared the tendency of the age is to go up the pressure scale as rapidly as vessels can be invented adapted for such increased pressure; and we have a conviction not easily removed that this tendency is a progressive one. A few years ago, 10 lbs. per square inch was a high pressure for marine boilers; now 20 lbs. is the usual pressure in new contracts, whilst 25 and 30 lbs. are not uncommon; either, therefore, the low pressure advocates must be in error, perhaps through not having clearly ascertained the value of some x y in their calculations, or—sad alternative—our progress is retrogressive.

As far as our judgment and experience can be relied on, we hold the opinion that the full economy obtainable from steam as a motive power can only be realized by employing the highest pressure of steam compatible with safety; and we also believe this opinion is held so strongly by our first engineers, that it will be exemplified in their practice to such an extent as improvements in the generators will permit.

The very method of designing engines prohibits much benefit from expansion. The diameter and length of cylinder is *first* decided on, and then a boiler is designed to fill that cylinder at least half full per half stroke; and, as the boilers weaken by age, the pressure and expansion are reduced together, so that a disgraceful beginning has a miserable end.

This defect in designing is very frequent with marine engines, for, in consequence of salt incrustation, a reduction of the pressure is more certain, and occurs earlier, than in land engines.

The generator should be the starting point of design; there should be no difficulty with a thoughtful and observant engineer in ascertaining what quantity of steam can be supplied, of a given pressure, with a fixed rate of combustion, and a fixed ratio between it and the heating surface. Having fixed his rate of supply, he can, with the most undeviating certainty, decide on his revolutions, rate of expansion, capacity of cylinder, and actual power required. But no; this, the most easy, most rational process, is considered the most difficult, and your practical man tells you that to get a certain speed out of a ship, "if you have a 50-inch cylinder, you will do it." Do it? yes, as many an unfortunate ship-owner has been "done."

Before leaving this part of the subject, it may be as well to allude to the advantages alleged to be derived from the combination of a high and low pressure cylinder; and it must be admitted that such engines have been more economical than ordinary single cylinder engines. But why is this so? Is it in consequence of the two-cylinder arrangement? This has never been proved. The reason we believe to be simply this—that all double cylinders are necessarily, by their very construction, *expansion* engines; whereas the cases are rare in which the single cylinder is fitted to carry out the expansion to an equal extent. With an equal amount of expansion, the single cylinder should be the most economical; at the same time, the double cylinder arrangement, although more complicated, has the most even motion during high expansion.

We have purposely avoided any theorizing as to the realized increased duty from various rates of expansion, as such information can be obtained from many sources. By a proper use of the expansive property of steam alone, we can effect a certain saving of at least one-half of the present cost of steam power.

Our next and last subject is connected with the disposal of the steam.

In locomotives and non-condensing engines the waste occasioned by the escaping steam will be in inverse proportion to the rate of expansion, and the abstraction of heat to raise the temperature of the feed-water. With reference to the latter, a saving of from 10 to 15 per cent. may always be obtained by passing the exhaust through or over the feed-water; but even this simple arrangement is often neglected—indeed, it is so in the majority of cases.

In condensing engines it is of great importance to reduce to a minimum the units of heat passed into the condenser; and here again we recognise the importance of extreme expansion and no premature condensation. Any defect that allows 2 lbs. of steam to do only the work of 1 lb. is not only a first loss in itself, but ultimately it injures the efficiency of the condenser by admitting into it nearly the total heat contained in 2 lbs. of steam, instead of only that contained in 1 lb. Hence, it is a proved fact, that with superheated steam or steam jackets, much less water is required to condense a horse-power of steam.

In speaking of steam generation, we called attention to the apparent necessity of the loss arising from the escape of the heated gases

requisite for a draft; and now, in concluding our remarks on the disposal of the steam, we have to confess that the discharge of a large mass of heated water appears an unavoidable loss; we take only some 4 per cent. of it to feed the boiler, and the remaining 96 per cent. is wasted. The temperature of the feed-water thus supplied, averaging 100°, *may* always be raised to 200° or more, by abstracting the heat from the brine, discharge, or scum, but it *is not.*

With steam of 20 ℔s., a vacuum of 10 or 12 ℔s. is an important addition, but it is questionable whether the addition of 10 ℔s. to a pressure of 150 will repay the cost of fitting and working the air pumps; all will depend upon the extent of expansion.

And now a word about surface condensation, and the advantages to be derived from its introduction into steamships.

It would be difficult to overrate those advantages. A saving of at least 20 per cent. of fuel—clean boilers—small air-pumps—regularity of feed—and, above all, the consequent introduction of high pressure steam.

It is matter of surprise and regret that such authorities as Mr. J. Scott Russell and Mr. Bourne should inform the young engineer that surface condensation is not sufficiently rapid. This is a bug-bear that has haunted many, and tended to repress an improvement that *will not* be repressed. It is not for us to say how or when surface condensation will be generally introduced; we can only put, on the one side, the many advantages its introduction creates, and, on the other, the trifling mechanical difficulties to be overcome, to effect its adoption. And who will question the result?

Next month we shall allude to the mechanism of the steam engine; and, in the following number, conclude the series with a *résumé* of the whole points touched upon.

(To be Continued.)

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*Boydell's Traction Engine in Manchester.**

Yesterday a trial journey from Manchester to Oldham was made with a new traction engine, which has been manufactured by Messrs. E. T. Bellhouse & Co. of Manchester, to be sent out to Rio de Janeiro, for Messrs. Carruthers, De Castro & Co. The engine, weighing about 15 tons, with a train of six wagons loaded each with 3 tons of iron, making on the whole a weight of 45 tons, was taken yesterday morning from Zara street, through the streets of the city, to Oldham road and on to Oldham. The engine performed its duty well, proceeding at the rate of two or three miles per hour, and turning sharp corners with facility and accuracy, answering to the will of the steersman with wonderful promptness.

* From the Lond. Builder, No. 880.

AMERICAN PATENTS.

List of American Patents which issued from December 6, to December 27, 1859, (inclusive,) with Exemplifications.

DECEMBER 6.

1. Hub-boring and Mortising Machines; G. M. Atherton, Friendsville, Illinois.

Claim—The arrangement of the pawls, with spring rods and arms projecting from the reciprocating gate for operating the same, in combination with lever for relieving either one or both pawls from racks, arranged for the purpose of moving the carriage with the hub up to the mortising tool.

2. Machines for Clearing Rice; Wilson Ager, Rohrsburg, Assignor to T. J. Wolf and P. J. Jordan, Philadelphia, Pennsylvania.

Claim—1st, Giving the grain a positive outward motion from under the pressing wings by the clearer. 2d, The adjustable leaves upon the wings, for aiding the upward movement of the grain.

3. Grinding Mills; C. P. Buckingham, Mount Vernon, Ohio.

Claim—1st, The method of securing the spindle to the runner stone of a grinding mill, by combining the flanch at the end of the spindle and the ring attached to the metal cap of the runner, said ring being provided with projections which shall permit a rocking motion of the stone upon the spindle, and a key. 2d, The use, in connexion with the bed-stone of the elastic bars, for the purpose specified.

4. Steam Boilers; B. N. Burke, Buffalo, New York.

Claim—The employment, in combination with the flues, arranged as described, of draft distributors, applied and furnished with apertures of varying size.

5. Steam Boilers; B. F. Campbell, Roxbury, Massachusetts.

Claim—The combination of the exterior water chamber and interior water chamber, the interposed smoke flue and the basin, arranged to operate as set forth.

6. Washing Machine; C. Carter, Franklin, Iowa.

Claim—The inclined wash-board, fitted between ways or guides, which have a sliding or reciprocating rubber frame fitted on them by being hinged to slides, fitted within a suitable box or suds' receptacle, and arranged as set forth. Further, the arrangement of the rubbers filled within the hinged reciprocating frame, and used in connexion with the inclined wash-board.

7. Sewing Machines; Edwin Clark, Windsor, Vermont.

Claim—The combination of the bar, which has its front end or needle controlled by a double fulcrum guide, so as to describe an ellipse, and its rear end attached to a rotating disc or crank pin, with a perforating needle.

8. Projectiles for Rifled Ordnance; J. W. Cochran, City of New York.

Claim—Fitting a projectile with a hollow case, jacket, or band, containing gunpowder or other explosive material, which, when ignited by the firing of the charge of the gun will, by its explosion, cause the said case, jacket, or band to be expanded toward the bore of the gun, and to be compressed around the projectile. Also, in combination with an expanding case, jacket, or band applied to a projectile, the use of an outer covering of wire cloth to constitute a packing.

9. Harvesters; William Cogswell and Ira Cogswell, Jr., Ottawa, Illinois.

Claim—The combination of the shifting pinion with the eccentric axle and adjusting frame, so that by turning the said axle, the pinion will be thrown into gear with either of the concentric wheels, or out of gear with both, and so that the height of the main frame may be readily adjusted to correspond with the adjustment given the axle and the pinion.

10. Water-wheel; J. P. Collins, Troy, New York.

Claim—1st, The arrangement of the lighter plate, in the particular manner specified. 2d, The arrangement, in the particular manner specified, of the packing ring. 3d, The arrangement, in the particular manner specified, of the lip or projecting piece of the buckets. 4th, The arrangement, in the particular manner specified, of the regulating plate, in combination with the peculiar specified device for operating it. 5th, The employment or use of the dividing strip or annular ring inserted in the buckets, as set forth. 6th, The employment for united use, in one wheel, of the lighter plate, packing ring, projecting lips, or flanches, gauge or regulating plate, and annular dividing plate, arranged in the manner set forth.

11. Boxes of Vertical Sugar Mills; John Cooper, Mount Vernon, Ohio.

Claim—The concentric cups upon the upper sides of the heads, the same being furnished with the openings for the conveyance of the oil from the upper box to the stationary cap which surrounds the shaft upon the lower bed plate, in combination with the cups, as described.

12. Skate Fastenings; T. P. Costello, Buffalo, New York.

Claim—A boot, with sockets therein, as described, and upright bolts welded to a steel blade or skate runner, both being made and arranged as described, and attached to each other.

13. Horizontal Water-wheels; E. G. Cushing, Dryden, New York.

Claim—The combination of the tubes with the bolts and buckets, arranged as described.

14. Hook-headed Spikes; G. W. R. Bayley, Brashear, Louisiana.

Claim—The improved railroad spike, having the sides and front of its head beveled downwards and inwards, but convex, and having the peculiar projecting lip or hook behind, for facilitating its easy withdrawal.

15. Melodeons; C. G. Burke, Utica, New York.

Claim—Fitting a melodeon, or other reed instrument of the same class, with a series of swell valves, so applied as to be capable of being operated by the keys in playing, for the purpose of giving expression to any note, independently of the preceding or succeeding ones or of the other notes of a chord. Also, the employment of a stop, applied and operating in combination with the keys and swell valves.

16. WIND-MILLS; Jacob Dickerson, Sacramento, California.

Claim—The arrangement of the curved iron sections, sails, arms, slides, hollow drum, scroll spring, flexible connecting rods, and links, in the manner described.

17. SEWING MACHINES; C. W. Dickinson, Newark, New Jersey.

Claim—The construction of a pendently swinging, gravitating, self-adjusting pressure pad or stripper, formed with an adjustable slotted end suspended on an adjusting pin or stud, the said pad having no feed pressure spring.

18. CARDING ENGINES; Jephtha Dyson, Fulton, South Carolina.

Claim—1st, The combination and arrangement of the feed regulating and working cylinder, feeder, worker, c, and clearer, in the manner described. 2d, The combination and arrangement of the feeder, worker, B, cleaning and delivering cylinder, and main cylinder, as described. 3d, The combination and arrangement of the feed regulating and working cylinder, feeder, worker, c, clearer, worker, B, clearing and delivering cylinder, and main cylinder, in the manner set forth. 4th, The combination, with the features included in the third claim of the stripper, in the manner set forth.

19. CORN CRIBS; A. B. Furbee, Dresden, Ohio.

Claim—The arrangement of the inclined flooring with the trunks or boxes, as set forth. Also, covering the posts of the crib with sheet metal, when said posts are used in connexion with a crib provided with an inclined flooring and trunks or boxes.

20. PLOUGHS; Jackson Gorham, Bairdstown, Georgia.

Claim—The arrangement of the vertical curved standard, shovel, curved handle straps, hooked inclined brace, adjustable brace, and adjustable beam, as described.

21. MACHINERY FOR CUTTING LEATHER INTO SOLES FOR BOOTS AND SHOES; Caleb H. Griffin, Assignor (through mediate assignment,) to Walter D. Richards, Lynn, Massachusetts; ante-dated June 6, 1859.

Claim—1st, Vibrating the knife or knives in the arc of a circle or a curve approximating thereto, in the manner set forth. 2d, The arm, stud, and slot, or their equivalents, as combined with the knife or knives.

22. RAILROAD CAR BLINDS; Daniel M. Hall, Bridgeport, Connecticut.

Claim—The use of the flexible blind, arranged with the rollers fitted within the curved grooves, and applied to the window of a car, or other wheel vehicle, so that it may be raised above the sash, and drawn within the roof of the vehicle.

23. BEARINGS OF RAILROAD AND OTHER MACHINERY; Alexander Hay, Philadelphia, Pennsylvania.

Claim—Imbedding the bearings of journals or surrounding the same with india rubber, or other suitable elastic material, so as to cause them to yield in every direction when subjected to strains and thrusts, and re-adjust themselves upon the pressure being removed.

24. DRYING WET SEED-COTTON; George G. Henry, Mobile, Alabama.

Claim—The application of artificial heat for the purpose of drying wet seed-cotton, by means of mechanism.

25. PITCH-FORKS; John Herald and C. B. Tompkins, Trumansburg, New York.

Claim—The arrangement of the hollow head and tines, passing through the head socket, handle, screw plugs, and screw tangs.

[This invention consists in constructing the head in T-form, of cast metal, hollow; the teeth being secured in the head, and the head secured to the handle.]

26. MOLE PLOUGHS; F. E. Hinckley, Galesburgh, Illinois.

Claim—1st, The combination of the clearer or hanging coulter and the rotating coulter, arranged as described. 2d, Constructing the sword of a mole plough with a hole or bore through it, of sufficient size and suitable shape to admit at the same time a rod of metal large enough to raise and lower the point of the mole, and also to admit the air to pass free into the drain through the sword and mole. 3d, Expanding and contracting the mole of a mole plough described, or by any other mechanical means. 4th, Constructing the mole of a mole plough in sections consisting of two sides and a top, hinged to a head block and operated by a wedge. 5th, Two revolving cutters, with plain outsides and conoidal insides, which may be placed upon a common axle and adjusted to the beam in such a manner as to be forced to cut into the ground, and press the earth laterally into the sword, cut and firmly close it up.

27. PORTABLE COLLECTION BOX; Truman J. Homer, St. Louis, Missouri.

Claim—The whole box as a portable collection box, in the peculiar arrangement of its component parts of glass, wood, and metal. I particularly claim the money inlet, it being in the shape of a box without a bottom, through the top of which is inserted a narrow flat tube, and between it and the sides of the box are two ranges of discs, which discs close the aperture of the tube when the box is inverted.

28. MACHINES FOR RAISING WEIGHTS; Sheldon A. Hotchkiss, New Haven, Connecticut.

Claim—The zone and the screw drum, pawl hook, knee, and sheeve, in combination, as set forth.

29. INDIA RUBBER FABRICS; E. E. Marcy, City of New York.

Claim—The improved india rubber fabric made by the combination of india rubber with hypo-sulphite of zinc, and by the exposure of said compound to steam or water at the temperature stated, without any admixture of free sulphur.

30. INDIA RUBBER FABRICS; E. E. Marcy, City of New York.

Claim—The improved india rubber fabric made by the combination of india rubber with sulphuret of lead and carbonate of lead, or the protoxyde of lead, and by the exposure of said compound to steam or water at the temperature stated, without any admixture of free sulphur.

31. INDIA RUBBER FABRICS; E. E. Marcy, City of New York.

Claim—The improved india rubber fabric made by the combination of india rubber with the sulphuret of zinc and hypo-sulphite of zinc, and by the exposure of said compound to steam or water at the temperature stated, without any admixture of free sulphur.

32. APPARATUS FOR SETTING AND COPYING MUSIC FOR THE BLIND; Emanuel Marquis, Bloomington, Indiana.

Claim—The tablet, or its equivalent, with raised staves and sockets, in combination with detached solid notes, and other signs of musical notation, or their equivalents, capable of being transposed on and fixed in the table.

33. Breech-loading Fire Arms; Samuel W. Marsh, Washington City, D. C.

Claim—The construction and application of a detachable-headed breech pin, with a split female expanding ring or collar, and a non-expanding male collar or ring, and a detachable adjusting screw head, forming a compound, expanding, detachable-headed breech pin, as shown.

34. Apparatus for Sanding Painted Surfaces; Edwin May, Indianapolis, Indiana.

Claim—The combination and arrangement of the blast fan in cylinder, A, conductor, adjustable mouthpiece, with the elastic tube, or its equivalent, arranged as set forth.

35. Breech-loading Fire Arms; Edward Maynard, Washington City, D. C.

Claim—1st, The peculiar manner of connecting the barrel to the breech-piece, viz: the hook on the underside of the barrel, taking hold of the pin, or the equivalent thereof, at the front end of the breech-piece, while the link, the lever, and the joint pins of said link and lever are arranged in such a manner, with relation to the slot in the breech-piece, and the ears on the underside of the butt of the barrel, as to form a treble-jointed and compound leverage connexion between the breech-piece and the butt of the barrel, of such a character that the barrel can be instantly thrown from a firing position to a loading position, and vice-versa; and also of such character that the barrel can be easily and quickly detached from the breech-piece or be securely united thereto, in the manner set forth. 2d, The combination of the metallic block, the screw, c, and the screw, a, with each other and with the front portion of the breech-piece, and in such a manner, with relation to the shoulder on the underside of the barrel, that the joint between the butt of the barrel and the abutment of the breech-piece can be tightened or loosened. 3d, Retaining the pivot pin in its position within the breech-piece, by means of the overlapping head of the screw—but this I only claim when the longitudinal groove in one side of a portion of the length of said pivot pin, is so located that when the pin is turned to the position shown, or any other previously-determined position, it may be drawn out far enough (and only far enough,) to detach the said pin from its hold upon the lever, and thereby allow the barrel to be separated from the breech-piece. 4th, When the pivot pin is retained in its position within the breech-piece by the overlapping head of the screw, in such a manner that it can be loosened by partially turning the same upon its axis—I also claim the arm upon the outer end of said pin, which enables it to be readily turned upon its axis, and partially withdrawn from its place without any mechanical assistance. 5th, When the barrel is connected to the breech-piece in the within described manner, I also claim the producing of a tight joint between the butt of the barrel and the abutment of the breech-piece, by combining therewith a flanch-bottomed metallic cup. 6th, Giving the opposite faces of the butt of the barrel such a shape, that the flanch-bottomed metallic cup can be easily taken hold of by the thumb and finger of the free hand of the user, when the barrel is thrown into the loading position.

36. Mode of Operating Car Brakes; G. W. Mitchell, Jackson, Tennessee.

Claim—The flanched or ratchet wheel and its hooked pawl, as described. Also, the spring platform and the pin attached, and stop-pin, as described.

37. Sewing Machines; G. W. Mitchell, Jackson, Tennessee.

Claim—1st, The combination of the crank on the driving shaft, the slotted arm forming a portion of the same lever with the needle arm, and so extended as to operate the lever, F′, and the lever, E′, carrying the shuttle or looper, arranged as described, to drive the needle and shuttle. 2d, The vertically and horizontally elastic arm, having the presser attached, and constructed so as to be operated upon by an appendage of the needle to feed the material. 3d, The polygonal collar fitted to turn upon the needle arm, so that any one of its sides may be presented to act upon the presser arm for the purpose of feeding the cloth more or less, according to the wish of the operator.

38. Iron Ships; Richard Montgomery, City of New York.

Claim—1st, Forming the supports or frame to which the side covering is attached, of iron or other metal corrugated, in the form and for the purposes as described. 2d, The combination and arrangement of the corrugated cross-beams and corrugated bottom supports with the iron divisions, as set forth.

39. Broiling Apparatus; Oscar F. Morrill, Boston, Massachusetts.

Claim—The improved steak broiler, as made with the deflector in its grid or grating, a flame and heat passage under the deflector, and, with the gravy trough, to surround or encompass the heat passage.

40. Clutch for Pulley Coupling; John Knickerbocker, Stockport, New York.

Claim—Suspending the clutches or impellers in radial slots in the disc of the movable pulley, so as to allow them to vibrate in the manner set forth.

41. Mode of Securing Photographs, &c., to Tombstones; N. W. Langley, East Cambridge, and Henry Jones and A. S. Drake, Stoughton, Massachusetts.

Claim—Securing daguerreotypes, photographs, &c., upon tombstones, by inclosing them in a glass case, the opening to which is closed by a glass stopper, and affixing the same to the stone.

42. Mounting Precious Stones, &c.; Thomas J. Linton, Providence, Rhode Island.

Claim—The improvement in making mountings for precious stones, and other articles of jewelry, which are to be mounted by forming the border setting and beveled edge from a single sheet of metal, at one operation, by the use of a die, in the manner described, the mountings being in an oval, round, square, or other form, as the article to be mounted may require.

43. Cotton Seed-hullers; Charles A. Lowber, Medina, New York.

Claim—Making the runner with the surface next to the shaft smooth, to receive the cotton seed from a suitable hopper and cause them to be properly distributed thereon, and to be carried towards the periphery, and with that part or the surface within the periphery, and outside of the smooth part armed with teeth in the form of long cutting edges, having continuous channels or furrows between them of sufficient size to receive a cotton seed and permit it to pass and roll therein, in combination with an upper plate surrounding the eye or aperture for the passage of the cotton seed to the smooth part of the surface of the runner, the under surface of the said plate being parallel with the surface of the said runner, and armed with a ring of teeth in the form of long cutting edges, and formed with interposed channels or furrows similar to those of the runner, but of reversed inclination, as specified. Also, making the said teeth of long cutting edges, and surrounding the smooth surface of the runner of varying lengths, as described, that is, having some of them approaching the shaft nearer than others, that the seeds, while traveling outward on the smooth surface of the runner, may arrange themselves and properly enter the furrows or channels one by one. Also, surrounding the periphery of the runner and upper plate with a trough which extends within the periphery of the runner, leaving an open space or air passage between, in combination with the vanes, or equivalent means, for blowing in a current of air, as specified.

44. Spark-arresters and Chimneys for Locomotive Engines; Washington A. Peaslee and John O. D. Lilly, Indianapolis, Indiana.

Claim—The construction of a chimney or spark-arrester, by the combination and arrangement of the various parts, as described.

45. Boiler-feeding Apparatus; Nathan Pucket, Deming, Indiana.

Claim—The arrangement of the chamber, valve, chest, and openings, as described.

[This invention consists in attaching a rectangular valve chest or chamber to the boiler, which communicates with the same through an aperture above the low water line, and with a feed-pipe extending to a heater in which the water is heated to a boiling point, through an aperture above the high water line, and providing said valve chest or chamber with a reciprocating valve, containing a chamber which shall alternately communicate with the openings leading to the feed-pipe and boiler, and receive from the former a full supply of water heated to a boiling point, which, when conveyed below and made to communicate with the water in the boiler, will evolve steam and discharge itself into the boiler until an equilibrium is established with the water in the same, thus producing a self-regulating feeder.]

46. Hinges; Samuel M. Richardson, City of New York.

Claim—Constructing hinges for blinds, by the bent straps passing around the outer edges of the blind, and enclosing the angle thereof, combined with the eye connected to said bent strap, by the part, e.

47. Harvesters; D. Sanford, Taylor, Illinois.

Claim—1st, The sliding rake bar fitted within the bent arm, and provided with a jointed rake head, in connexion with the guide strip and a gavel passage on the platform. 2d, The combination of the tilting gavel receiver with the tilting box, arranged to operate automatically.

48. Churn; Henry Bohrer, Strasburg Township, Lancaster Co., Pennsylvania.

Claim—The application of the tube, I K, to enter the rear head of the churn, the connecting pipes, C and H, and its wide mouth, partition, and connecting tubes, L M, with the dashers elevated on an open step, combined in the manner specified.

49. Artificial Hands; Wm. Selpho and James Walber, City of New York.

Claim—1st, The arrangement of the cords or catguts and the pulley, as set forth, for applying a double purchase in opening the hand. 2d, The arrangement of the wrist-joint and hand spring, whereby the said spring can be adjusted by the rod that passes through the pipe. 3d, The cord, or its equivalent, passing from the elbow-pad, and giving motion at the wrist, as specified.

50. Sheet Metal Coffins; Isaac C. Shuler, Amsterdam, New York.

Claim—1st, The arrangement of stiffening the base of a sheet metal coffin by locking together the surplus edges of the walls and bottom, forming a rim surrounding the base, also the frame. 2d, The inside tray, whose bottom is in permanent contact with the exterior bottom, and whose sides may be soldered directly to the walls or set away, leaving a chamber to be filled with molten metal. 3d, The arrangement of scrolling or double-locking the walls at the corners, in order, by making a voluminous joint, to stiffen and brace the general structure, whether the body of the joint be formed on the inner or outside of the coffin. 4th, The slotted or double rim, through which the walls protrude, for the purpose of stiffening the upper edges of the walls and sustaining the lid or cover; also, the arrangement of folding the surplus edges of the walls over the frame. 5th, Stiffening the cover with the frame near its outer edge on the upper side, enclosing the surplus sheet metal over the same. 6th, For the purposes of stiffening the respective portions of the coffin, the frames of cast or wrought metal, for the blind, for the cover, for the walls in the vicinity of the handles, for the upper edge of the tray, for the exterior bottom. 7th, I disclaim hinging the sections of the concave sides of the cover to the body of the same, but—I claim hinging them to the body of the coffin.

51. Hay-making Machines; J. C. Stoddard, Worcester, Massachusetts.

Claim—1st, The rake head shaft, furnished with friction wheels or rollers, which are arranged on pivoted lever bearings, in combination with driving wheels which are furnished with a plain flanch for the friction rollers to act against, so that the necessary friction may be produced either by means of the specified lever arrangement, or by the same in combination with the gravity of the rake head, as set forth. 2d, The adjustable spurred ring, set-screws, with the wheels on the ends of the rake bars, arranged as set forth.

52. Saw-mills; Samuel Tasver, White County, Arkansas.

Claim—1st, The arrangement of the parts—I say arrangement, because I cannot claim the invention of pulleys, saws, rollers, shafts, &c., these being in use everywhere, but simply claim the peculiar manner in which they are arranged. 2d, The construction of the saw carriage, as described.

53. Machine for Making Cigars; Thomas Thorpe, City of New York.

Claim—1st, The arrangement of the drums or pulleys, in connexion with the rollers, M, and belt, with or without the rollers, N, as set forth. 2d, In connexion with the above, the runged wheel, or its equivalent, arranged in the manner set forth. 3d, The means described, of regulating the pressure on the cigar. 4th, The arrangement of a machine, as set forth. 5th, The peculiar steady curves or bends given to the belt, for the purposes mentioned.

54. Rotary Cutter-head; J. P. Tice, Baltimore, Maryland.

Claim—The employment or use of a cylinder, or any segment or section thereof, applied to rotary cutters, to operate as set forth.

55. Washing Machine; George W. Tolhurst, Liverpool, Ohio.

Claim—Constructing the round follower of washing machines of two sets of rings or hoops, and furnishing each set of rings with a handle, so that the surface that comes in contact with the clothes can move in opposite directions at one time; and this I claim when the same is arranged for operation, in the manner described.

56. Machine for Girdling and Felling Trees; A. P. Torrence, Oxford, Georgia.

Claim—The employment or use of the handle, provided with a cutter, and connected to a draft lever by the bars, or any equivalent means, so as to operate substantially as set forth.

57. Clapboard Gauge; Hiram Van Dusen, Phelps, Assignor to self and H. Rockfellow, Clifton Springs, New York.

Claim—A gauge for fitting clapboards for railing, composed of the bar, the arm, the slide, with the cam and lever by which it is actuated, the stop, and the straight edge, or their equivalents, arranged as set forth

58. Rollers for Printing Paper Hangings; Theodore Van Deventer, New Brunswick, New Jersey.

Claim—The combination of the conically bored and grooved bushes, the concentric feathered collars, the feathered and screwed shaft, and the nuts, applied as described.

59. Dental Apparatus for Relief of Pain while Operating; Nahum Washburn, Bridgewater, Mass.

Claim—The combination of dental forceps, or instrument for operating upon teeth, with electro-magnetic mechanism, or its equivalent, so that the electrical current or currents may be made to flow through the nerve or nerves of the tooth, or the jaw or flesh immediately contiguous thereto, in order to benumb the same and render such more or less insensible to pain during the performance of the dental operation. Also, particularly the application of the electrical apparatus to the dental instrument, so that the latter may be in, or form part of, the circuit, as specified.

60. Threshing Machines; D. A. Willbanks, Harmony Grove, Georgia.

Claim—The peculiar construction of the wrought iron ribs, in combination with the peculiar construction and arrangement of the cylinder heads, to wit: the ribs with angular hooks, and the cylinder heads with key seats, and with the slotted projections and radial slots, as set forth.

61. Ploughs; William F. Yeager, Starkville, Mississippi.

Claim—The arrangement of the land-side, the shank, slot, brace, T, lug, beam, brace, X, handles, share, cutter, and mould-board, constructed as described.

62. Registering Machines; George W. Atkins, Milton, Delaware, and William B. Aitkins, Philadelphia, Pa., Assignors to G. W. Atkins and J. B. Henry, Delaware City, Delaware.

Claim—1st, Making the ratchet wheels in pairs secured together, with their notches inclined in opposite directions, in combination with both an actuating and a checking pawl, operating together simultaneously, arranged in the manner described. 2d, The employment of a self-righting cover, operating in combination with the platform, or its equivalent, in the manner described—and this we claim whether the said cover be applied either to a fixed platform or floor, or to the moving platform of a weighing scale, connected with a registering machine. 3d, The bell-striker, when the same is constructed with arms, and operated by the notches of the ratchet wheel, as described.

63. Tool for Finishing Felloes; Charles H. Dennison, Guilford, Assignor to A. Miller, Brattleboro', Vt.

Claim—1st, The described washer and the iron gauge for trimming and shaping the internal surface of felloes, &c. 2d, The described collar gauges for squaring the external and internal curved surfaces of the felloe.

64. Ladle and Fork; William B. Dunbar, Waterbury, Assignor to self and George H. Seymour, Plymouth, Connecticut.

Claim—The combined ladle and fork, constructed in the manner described.

65. Casting Boxes for Wheel Hubs; Thomas Ellis, Assignor to self, W. A. Ellis, and A. D. Ellis, Philadelphia, Pennsylvania.

Claim—Supporting the sand core between two sand heads, when the above parts are employed in connexion with a sand mould, in the manner represented.

66. Machines for Forming Hat Bodies; Richard Fitzgerald, Assignor to James Booth, Newark, New Jersey.

Claim—1st, Distributing the fur on the former by discharging the same through an annular opening, over and co-centric with the former. 2d, The employment or use of the stationary shell provided with the recess, cards, or pickers, q r, and having within it the co-centric rotary wheels, one or more, also provided with cards or pickers, v u, and with or without fan blades, arranged relatively with the former. 3d, The employment or use of the slide with the sliding tube or pipe fitted therein, containing the former shaft, the box, and elastic belt, or its equivalent, arranged relatively with the suction fan, and the shell, and wheels, as specified.

67. Horse Hay Rakes; George N. Hall, Assignor to self, S. Arthur, and J. Pierce, Mamakating, New York, and D. S. Arthur, City of New York.

Claim—The arrangement of the main lever, intermediate link, auxiliary lever, connecting rod, cam, arm rake head, slotted brace bar, and driver's seat, as set forth.

68. Steam Ploughs; James W. McLean, Assignor to self and Edwin May, Indianapolis, Indiana.

Claim—The arrangement of the ploughs, gearing, cutters, lever, and connecting rod, in combination with the universal jointed shaft, when operated in connexion with the steam engine, as set forth.

69. Peg Tubes and Drivers; John P. Kemp, Charlestown, Massachusetts, Assignor to N. F. Stevens, Moultonboro', New Hampshire.

Claim—Constructing the interior peg-guiding portion of the tube of a form made up of angles or corners and surfaces, as described, and so that, while the cross section or area thereof is materially greater than that of the peg, to admit of a driver of increased strength and materially greater cross section or area than that of the peg working therein, said tube in its peg-guiding portion serves, by its corners or angles and surfaces, to restrain the peg from lateral shake or play.

70. Cattle Pumps; Warren Nichols, Lima, Assignor to self and Thomas Ghormley, Stokes, Ohio.

Claim—1st, The combination with the covers of the stops which will open the trough, when its corresponding platform rises to its highest position, and close it when the platform descends to its lowest position, as described. 2d, The arrangement described of the spout, in combination with the arm or with some other part operated by the descent of one of the platforms, by which the direction of the water is changed near the close of the descent of the platform.

71. Cut-off Valves of Steam Engines; George H. Reynolds, Assignor to Caleb Barstow and D. D. Badger, City of New York.

Claim—The arrangement within each steam chest of a rotary engine of the starting and reversing valve having the cut-off valve, in combination therewith, the two being so coupled and operating that the starting or reversing may be effected without coupling or uncoupling any of the connecting parts, in the manner set forth.

72. Mode of Applying Sulphurous Acid Gas in the Defecation of Cane Juice; Nancy P. Brashear, of the Parish of St. Mary, Executrix of Robert B. Brashear, deceased, late of Pattersonville, Louisiana.

Claim—Subjecting sugar cane juice, or other saccharine liquid, to the direct action of the fumes of burning sulphur, such liquid being employed in a diffused state, so that every or nearly every portion of the whole body of liquid is brought in contact with the same almost simultaneously, as set forth.

73. Fastening for Cartridge Boxes; Rebecca H. Willson, Administratrix of the estate of John M. Willson, deceased, Washington City, D. C.

Claim—A cartridge box fastening, composed of hinged lever and spring, said spring serving to hold the lever open or closed, and said lever, by the aid of said spring, clamping the flap of the cartridge box between itself and the side of said box, as represented.

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74. Car Couplings; Luther Adams, Blanchester, Ohio.

Claim—The combination and arrangement of the latch, spring, and plates, constructed as described.

75. Cotton Seed Planters; Peter B. Baker, Wall Hill, Mississippi.

Claim—The arrangement of the teeth in front of the drill-opener, and the scraper secured upon the spring runners or shoes, in combination with the seed drum, in the manner specified.

76. Sash-fastener; Nelson Barnum, St. Louis, Missouri.

Claim—The lever, the adjustable connexion, and the springs, and bolt, in combination with the yielding strip, as specified.

77. Running Gear of Vehicles; A. R. Bartram, Redding, Connecticut.

Claim—Attaching the front axle to the bolster, by means of the sleeves fitted loosely on the bolster and connected with the bar, which is attached to a circle plate or any suitable swivel connexion, between the said bar and axle, when said parts are used in connexion with thills, or a draft pole attached rigidly to the axle.

78. Double Eye-piece for Optical Instruments; Alexander Beckers, City of New York.

Claim—Connecting a stereoscope or other optical instrument, with double eye tubes, sight tubes, or eye-pieces, each of which being shaped or turned of one piece in the form of an obliquely intersected and moulded hollow cylinder, in the manner described.

79. Composition for Kindling Fire; Elizabeth Bellinger, Mohawk, New York.

Claim—The inflammable gum paste composed of Kaurie gum, camphor, and wax, in about the proportions stated, when combined with friction-match paste, placed on kindlers for fires, in the manner set forth.

80. Bolting and Cleaning Clover Seed; John H. Birdsell, West Henrietta, New York.

Claim—1st, Operating the bolts so as to impart to them an oblique alternately rising and falling motion, by means of the double crank, guide rods, arms, and connecting rods, or their equivalents, in the manner set forth. 2d, Arranging the trough provided with endless conveyors, for the purpose of returning the unhulled seed or tailings to be again submitted to the operation of hulling.

81. Seed Planters; William Blessing, Jeffersonville, Ohio.

Claim—The arrangement of the top portion of the distributor made with a semi-lunar opening, and the recess under the covered portion of the said top, when the periphery of the top is made with the chaff openings on either side of the reciprocating seed bar, so that said bar, by its reciprocating action, shall work out the chaff through the passages on either side of the seed bar, and thus prevent choking the distributor.

82. Striking Apparatus for Gongs; Jeremy W. Bliss, Hartford, Connecticut.

Claim—1st, Arranging the striking mechanism of a bell within the hollow bell, when the wire which actuates the mechanism moves in lines parallel to the axis of the bell, or nearly so. 2d, A rock shaft arm, arranged with reference to the bell, in combination with a slide, a swing-catch, and a hammer, and hammer wire, and proper springs, as set forth.

83. Grinding Mills; John Broughton, City of New York.

Claim—1st, The double and reverse-acting conical grinding surfaces, constructed as set forth. 2d, In combination with a revolving grinder and hollow case or drum, I claim the wings or fan blades, operating as set forth.

84. Portable Fences; Peter M. Brown, Carrollton, Illinois.

Claim—Giving such a shape to the slots at each end of the sections, that the said sections can be securely interlocked with each other by means of supporting posts of the within described shape, in such a manner that the said sections can be either lengthened or shortened when they are put up for use.

85. Fan-governors for Steam Engines; Isaac Y. Chubbuck, Roxbury, Massachusetts.

Claim—Combining the main spindle of the fan-governor with the stem or spindle of the valve, by means of a toothed arc formed upon, or attached to, the extremity of the crank arm which carries the fan, and a toothed sector upon the valve stem, the said crank arm being attached to a sleeve fitted to the spindle.

86. Machines for Winding Thread on Spools; Hezekiah Conant, Willimantic, Connecticut; patented in England, June 22, 1859.

Claim—1st, The combination of a traverse changer with right and left-hand screws, and with nuts which are alternately in gear with such screws, the combination operating as a whole. 2d, A traverse changer provided with successive steps or teeth, substantially such as is before described, and acting upon lips, as set forth. 3d, A stop motion, for causing the machine to come to rest when a spool is filled, in combination with automatic apparatus, for regulating the length of motion and change of direction of motion of a guide, through which the thread is delivered on to a bobbin or spool. 4th. Adjustable lips, in combination with a traverse changer, whereby spools of different lengths may be wound by the use of the same traverse changer. 5th, Mounting the presser and thread guide directly upon or attaching it firmly to the traverse rod, as before described, whereby the machine is cheapened and performs its work more accurately. And lastly, in combination with apparatus such as described, for governing automatically the motions of a thread guide, I claim a tension apparatus and stop motion which arrests the motion of a machine when a thread breaks, by the mode of operation set forth.

87. Sash Weights; John B. Cornell, City of New York.

Claim—My improved metallic sash weight, the peculiarity of which consists in its having a series of annular grooves formed at suitable distances from each other, in the lower portion of said sash weight.

88. Machine for Wiring Blind Rods; Thomas R. Crosby, Newark, New Jersey.

Claim—1st, The use, in wiring machines, of the yielding mouth to hold the wire when being driven and formed. 2d, The use of the adjustable slide, in the manner described. 3d, In said machines the use of the

dog in the end of the arm, in the manner described. 4th, The combination together of the driver and the yielding mouth formed by the rack and plate.

89. NEEDLE WRAPPERS; R. Crowley, City of New York.

Claim—The incision of the wrapper, so as to expose the heads of the needles and produce a covering or flap of the form shown, or equivalent form.

90. MACHINE FOR MAKING CLASPS; Jonathan Cutler, Chicopee, Massachusetts.

Claim—1st, The sliding former and the vibrating lever, in combination with the die and punches. 2d, The reciprocating ring to actuate the slide former, in combination with the revolving cam, lever arm, and pin, M. 3d, The centre spring pin, W, to press the blank down through the die plate on the forming bed, in the manner described. 4th, The whole arrangement in combination, as an organized automatic machine, in the manner set forth.

91. SEEDING MACHINES; O. H. Dennis, Altona, Illinois.

Claim—The combination and arrangement of the cylinder, O, of circular cutters, with the cultivating and opening teeth, and with the sowing cylinder, H, in the manner set forth. Also, in combination with the above, the arrangement of the loosely hinged harrows, in relation to each other and to the frame of the machine, and in combination with the arms, rock shaft, lever, and catch.

92. STONE-LOADING WAGONS; D. S. Fancher, Logansport, Indiana.

Claim—1st, The inclined frame or bed and the hinged drop, in combination with the friction rollers and the windlass. 2d, The receiving table, in combination with the clamps, as described.

93. STEAM PLOUGHS; J. W. Fawkes, Christiana, Pennsylvania.

Claim—1st, The arrangement of the clutch, levers, M N, rod, lever, b′, and button or projection, on the chain, F, whereby the chains, F F, are wound on the pulleys of the shaft, and stopped automatically at the proper time. 2d, In combination with the above, the brake and pawl, when applied to the machine to operate simultaneously, as described.

94. GAS METRES; Thomas B. Fogarty, Charleston, South Carolina.

Claim—1st, The combination with the water reservoir and the revolving measuring drum, of an inclined feed wheel, as set forth. 2d, The arrangement of the overflow pipe, in combination with the water reservoir, metre chamber, dry well, and pipe, in the manner set forth. 3d, The arrangement of the water inlet, in the manner set forth.

[This invention consists, first, in the arrangement of an inclined wheel within a separate reservoir made by elongating the case of the metre, and in fixing upon the periphery of this wheel suitable buckets, which shall alternately dip into the water contained in said reservoir, and convey the same into the main reservoir, thereby maintaining a correct water-line under all ordinary circumstances, and effecting an equitable registration of gas. It consists, secondly, in preventing the metre from being overcharged, by the employment of a pipe extending up near the water-line, and communicating from the supply reservoir to the bottom of the dry well in front of the metre, so that should any attempt be made to overcharge the reservoir, the water will escape through this pipe, and rise into the dry well and stop the flow of gas completely. Also, in a peculiar arrangement of the water inlet pipe, so that it will have no communication with the body of the metre.]

95. HORIZONTAL WATER-WHEELS; A. M. Ford and C. W. Warner, Jericho, Vermont.

Claim—The construction and arrangement of the lifter and band, and of the buckets, combined in the manner set forth.

96. AXLES OR SHAFTS; George Foster, Brooklyn, New York.

Claim—A shaft or axle, cellular in its character and composed of a series of wrought iron rods or tubes, covered and held together by a casting cast upon the same, and forming the journal wheel, bearing section wheel, and pulley.

97. MOLE PLOUGHS; W. P. Goolman, Dublin, Assignor to self and Samuel B. Morris, Wayne Co., Indiana.

Claim—1st, The lever, rigidly attached to a pivoted mole in the described combination with the rack, arranged and operating as set forth. 2d, The cam, in the described combination with the coulter and adjustable pivoted mole, operating as set forth.

98. PRESERVING FLESH AND MEATS; Magnus Gross, Washington City, D. C.

Claim—The application of an air-tight apparatus of displacement to which hydrostatic pressure is applied, for the purpose and in the manner set forth.

99. STICKS FOR EXHIBITION ROCKETS; Charles Hadfield, Brooklyn, New York.

Claim—The rocket stick enclosing or in connexion with a magazine of powder, in the manner set forth.

100. CANDLE MOULDS; H. Halvorson, Cambridge, Massachusetts.

Claim—The combination with an outer tube of the inner elastic slit tube, applied and operating as set forth. And in combination with the elastic tube, I claim the tip of elastic or yielding material, applied and operating as described.

101. WASHING MACHINE; Ira Hann, Hope, New Jersey.

Claim—The combination of the fixed rubber board with the removable rubber, friction roll, presser carriage, and operating lever, arranged as described.

102. BEE-HIVES; J. S. Harbison, Sacramento, California.

Claim—Placing the bee comb, known as worker cells, in a horizontal, or nearly horizontal position, so that the cells shall be vertical, or nearly vertical, instead of horizontal, by the means as set forth.

103. BUTLER'S TRAY; William Hoffman, Benicia, California.

Claim—A single-handed butler's tray, furnished with a hinged or pivoted handle, so as to be detached or swing out of the way, to facilitate the placing or removing of articles upon it, and to economize room and space in carrying or stowing it away.

104. RATCHET PULLEYS FOR BLIND CORDS; J. B. Holmes, Jr., City of New York.

Claim—The metallic bar projecting from the window casing, and having teeth on the back thereof, in combination with the bridle pawl passing around said bar, and carrying the pulley for the cord. Also, the porcelain roller on the centre-pin, in combination with the bridle pawl and bar.

105. CLAMPS FOR METAL STRAPS; A. H. Hook, City of New York.

Claim—The outer griper and nail for fastening the ends of bale and other straps, constructed as set forth.

106. HOOP LOCKS; Daniel Hughes, Rochester, New York.

Claim—The case or box, having slots in two opposite sides, and provided with a clamp or jaw, arranged as set forth.

107. BOOTS; Peter Keffer, Reading, Pennsylvania.

Claim—The described mode of making the leg of the boot, the leather being folded in front, and the crimp hammered in, instead of crimping in the usual way, and the ankle being completed by a single seam and one piece of leather, as set forth.

108. HARVESTERS; L. G. Kniffen, North Salem, New York.

Claim—Constructing, as a whole, the shoe on which the cutter and finger bars are supported and adjusted in one piece, combining the guide box for the cutter bar, the recess for the finger bar, the slotted bracket for the castor wheel to be attached to the vertical locking portion, the vertical pivot or gudgeon, for the whole to be suspended or adjusted on horizontally, to a position parallel with the inner side of the main frame, as set forth.

109. METALLIC WINDOW BLINDS; G. A. Lathrop, East Saginaw, Michigan.

Claim—The arrangement of the plate with slots, slats or water-sheds, and grooves, in combination with the slotted slide, as specified.

110. SEED PLANTERS; J. A. Lee, Camanche, Iowa.

Claim—The arrangement of the bar, F, cord, rotary shaft, sliding seed-box, bars, c, lever, and sliding axle, as described.

111. APPARATUS FOR MOULDING CANDLES; Horatio Leonard and Henry Ryder, New Bedford, Massachusetts.

Claim—Making the receiver or trough separate from the body of the mould or series of moulds, and so constructed and arranged as to operate therewith, in the manner set forth. Also, the described improved mode of packing the lower orifice of the mould, viz: by means of a spring furnished with rubber or other proper elastic material, the same being arranged and made to operate with respect to the said orifice, as set forth.

112. MACHINE FOR CUTTING RAILWAY BARS; Benjamin A. Mason, Newport, Rhode Island.

Claim—For giving to rails the form described, the combination of the series of cutters, arranged in relation to each other, as described.

113. CORN PLANTERS; O. C. McCune, Darby Creek, Ohio.

Claim—The arrangement of the peculiarly formed rack bar rod, bent lever, pawl, ring, cam, and arm, as described.

[This invention consists in placing in rear of the plough, used to form the furrow in which the corn is deposited, a shovel or coverer, and in operating the same by suitable connecting rods and levers, so as to cover the corn in hills, after being deposited in the furrow.]

114. VEGETABLE-SLICER; Chauncey Parmelee, Wilmington, Vermont.

Claim—Supporting the front end of the adjustable plane of bottom on the fixed bottom board of the hopper, so that it shall be stationary relatively to the gate, and arranging at the end of the plane the mechanism for raising it. Also, the application of the board or partition to the hopper and the adjustable platform, in the manner specified.

115. SPECTACLE FRAME; William H. Peckham, Hoboken, New Jersey.

Claim—Connecting the end pieces of spectacle frames by the clasp sockets, in the manner specified.

116. METHOD OF PROTECTING FRICTIONAL ELECTRIC MACHINES FROM MOISTURE; Charles A. Seeley, City of New York.

Claim—Enclosing an electrical machine in a covering or box, which is nearly or quite air-tight, and, by means of an absorbent moisture, preserving the air about the machine nearly uniformly dry. Also, the insulating covering or box, as described.

117. NUT MACHINES; Andrew J. Shepard, Buffalo, New York.

Claim—1st, Perforating the punch, e, as described. 2d, The cutters, constructed and arranged relatively to the dies, as described. 3d, The combination of the dies with the water chambers, l and m, arranged as described. 4th, The combination and arrangement of the punch, D, with the water chamber, 7, and openings, as described.

118. ATTACHING SPOKES OF CARRIAGE WHEELS; Joel Y. Schelly, Hereford, Pennsylvania.

Claim—1st, The ferrule, furnished with rings, and applied in the manner set forth. 2d, The screw plates, welded upon the inside face of the tire, in the manner set forth. 3d, The combination of (with suitable slots made in the inside face of the tire,) the bolt, e, key-bolt, g, and plate, arranged in the manner specified, for securing the tire rigidly in its place upon the wheel.

119. MANURE DRILLS; G. B. Singeltery, Greenville, North Carolina.

Claim—The arrangement of the plough, guide board, lifting bar, guiding bar, and rotating hopper or receptacle, as described.

120. HEMP-BREAKING MACHINES; Stephen Stafford, Carrollton, Missouri.

Claim—Constructing the brake with two discs and heads, and uniting said discs by means of rounds or slats armed with obliquely-set teeth, and arranged so that spaces shall exist between them, and they can be adjusted to give the teeth any required obliquity, as set forth.

121. WATCH KEYS; John F. Sterling, San Francisco, California.

Claim—A watch or door key with a hollow stem or pod, open at both its ends, so that anything getting into it that would obstruct its action will drop or be punched out through the open stem.

122. BELTING FOR PULLEYS; Euclid C. Thayer, Providence, Rhode Island.

Claim—The manufacture of round belting by preparing the leather, or other material, in the mode described, and rolling and twisting the same in a spiral form with any required number of conical layers in the cylinder, either with or without a cylindrical space in the centre of the belt, and cementing the layers in the process of manufacture, as described.

123. BEE-HIVES; T. S. Underhill, St. Johnsville, New York.

Claim—1st, The arrangement of the movable frame, in combination with the sliding hive and adjustable side, as set forth. 2d, The arrangement of the adjustable boards placed on a frame, when said parts are constructed as described, and used in connexion with the sliding hive, for the purpose specified.

124. HAND CAR FOR RAILROADS; Antony Welsch, Chicago, Illinois.

Claim—The movable platform, and the attachment thereto of the crank and wheel, in the manner set forth.

125. DISPENSING WITH SWITCHES ON RAILROADS; William Wharton, Philadelphia, Pennsylvania.

Claim—The employment of a car wheel, provided with one or more treads in addition to the ordinary tread upon either the outer or inner side of said ordinary tread, and of the same or different diameter as said ordinary tread, in combination with additional raised rail or rails with a gradual rise, either curved or straight, so placed that such of the said extra treads as desired shall be caused to run upon them, thereby raising the car entirely clear of the ordinary track, and causing it to follow the direction of said raised rail or rails, whether curved or straight, for the purpose of avoiding the necessity for railroad switches, arranged as set forth.

126. SEED PLANTERS; Wm. H. Worth and Leonard Finlay, Canton, Missouri.

Claim—The arrangement of the longitudinally moving slotted plate, vertical gate, sliding bar, operating lever, shoes, and rotary coulters, as described.

[The nature of this invention consists in the arrangement of rotary cutters placed before the shoes for forming the drill, and hung upon a pivoted frame in such manner that they will conform to the irregularities of the surface of the ground in the operation of planting the corn. It also consists, in connexion with a reciprocating seed slide for depositing the seed in the shoe, in arranging a vertical gate, working in the heel of the shoe, and operated by means of a peculiarly slotted piece fixed to the seed slide, so as to deposit the seed in the drill from the shoe at regular and required intervals along the line of the furrow; the corn being retained in the heel of the shoe until the lever is moved back ready to receive another charge of seed.]

127. SEED PLANTERS; Henry Bell, Assignor to Fenton F. Bogar and Joseph W. Tidball, Clinton, Illinois.

Claim—1st, The arrangement and combination of the rock shaft, cog segments, pinion, crank shaft, ratchet bars, springs, feed slide, and discharge regulating valve, arranged and combined in the manner set forth. 2d, In combination with the above, the arrangement of the treadle and hand lever, together and on the same fulcrum, so that the feed slide can be worked either by the hand or foot, as set forth. 3d, The combination with the foregoing peculiar arrangement of parts for dropping the seed, the arrangement of a b c d, for regulating the depth of the furrow-openers, as set forth.

128. REVIVIFYING BONE BLACK; Wm. Bellows, Assignor to self and Charles W. Smith, Cincinnati, Ohio.

Claim—1st, An apparatus for revivifying bone black, arranged and constructed as described. 2d, The fastening bottoms of the retorts, arranged and combined with the described apparatus, for the purpose specified. 3d, The flanches, in combination with the retorts, for the purpose of allowing for expansion and contraction and replacing of retorts, as well as protecting internal heating surface, as described. 4th, The chamber between flanches and lower plates, for the purpose of preventing undue radiation of heat, and for the purpose of passing off the offensive gases arising from retorts when said chamber is combined with flanches and cover plates, for the purpose described.

129. HYDRO-CARBON VAPOR APPARATUS; George H. Bronson, Assignor to self and David Millard, Cincinnati, Ohio.

Claim—The arrangement and combination of the zigzag folded surfaces extending over the projecting edges, F, with the projecting edges, E C C C C, &c., in each of the several cells or chambers of the impregnating apparatus, in the manner set forth.

130. CHURN; Mortimer S. Harsha, Assignor to self, Rufus S. Sanborn, and H. B. Jones, Sycamore, Illinois.

Claim—An entirely stationary brake-dash, in combination with a cream-receiver, made to rotate on a vertical or upright shaft, as described.

131. GRAVEL CARS; Thomas C. Hendry, Assignor to self, J. Dillworth, and F. E. Askin, Conyers, Georgia.

Claim—The combination of the double inclined bottom and swinging doors, the latter being operated by the rods, bar, and lever, as set forth.

132. CONNECTING ELLIPTIC SPRINGS TO VEHICLES; James W. Lawrence, Assignor to self, Henry Brewster, and John W. Britton, City of New York.

Claim—The manner of combining and securing the back axle and the elliptic spring, as described.

133. SEWING MACHINES; Charles Miller, Assignor to George Ricardo, City of New York.

Claim—1st, The combination with the shuttle-driver of the releasing plate and lifter, as described. 2d, The employment of a shuttle made of two springs, in the peculiar manner described, in combination with the bobbin.

[This invention consists in the employment, in combination with a feeding dog operating below or at the back of the material being sewed, with a simple reciprocating rectilinear motion parallel with the surface of the material, and a presser acting on the top or in front of the material to press it against or towards the teeth or face of the dog, of a plate, which may be termed a releasing plate, arranged on the same side of the material as the dog, and having a movement in a direction perpendicular, or nearly so, to the face of the material, for the purpose of lifting the material and keeping it released from the dog during the backward movement of the latter. The invention also consists in effecting the releasing movement of the said releasing plate by means of a wedge-like projection, or its equivalent, formed upon or carried by a shuttle-driver.]

134. SHINGLE MACHINES; E. R. Morrison, Assignor to S. C. Hill, Brooklyn, New York.

Claim—1st, The arrangement of the knife, H, and projection, V, in connexion with the reciprocating bed, whereby the bolt is supported as the bed passes underneath it during the cutting or riving operation. 2d, The employment or use of the planers or knives, C C, operated by the plates, bar, and ledge or projection, F, on the bed, as described.

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135. APPLE-PARER, CORER, AND SLICER; John I. Armfield, Jamestown, North Carolina.

Claim—The combination of the two levers, B C, connected by the link, one lever, B, being provided with the cutter, and the other lever, C, having one end fitted on the arbor, as set forth.

136. CATTLE PUMPS; John Augspurger, Trenton, Ohio.

Claim—1st, The combination and arrangement of the platform, levers, springs, weights, rods, and brake wheels, operating as set forth. 2d, The arrangement of the float, rod, and valve, in the described combination with and relation to the bucket and hinged platform, operating in the manner explained.

137. LOCOMOTIVE TRACTION VEHICLES; John H. Bailey, Sand Ford, Indiana.

Claim—1st, The means employed for rotating or communicating power to the wheels, D D, to wit: the fixed pinion, p, on the shaft, loose or sliding pinions, q q, wheels, s, pinions, v, and toothed rims, as described. 2d, The combination of the wheels, J D D, when applied to a traction engine, and arranged for joint operation, as set forth.

[This invention is more especially designed for agricultural purposes, such as the drawing of gang ploughs, harrows, seeding machines, &c. The invention consists in a peculiar arrangement of the driving gear, and the manner of applying the power thereto, whereby the machine is placed under the perfect control of the driver or attendant.]

138. BLANKETS FOR PRINTING; S. W. Baker, Providence, Rhode Island.

Claim—A rubber or gutta percha, or other elastic printing band or blanket, having either roughened selvages or margins, or the whole of its surface roughened, as set forth.

139. WRENCH; A. J. Bell, Greenupsburgh, Kentucky.

Claim—The combination of the jointed lever, wedge, and tooth, with the sliding jaw and bar, as described.

140. HOISTING MACHINES; Albert Betteley, Boston, Massachusetts.

Claim—1st, Bringing the car to a stop whenever (while in motion) its door may be opened, by causing the shipper rope to be pinched or held, as described. 2d, The arrangement, substantially as specified, for causing the car to be stopped at proper times and places, said arrangement consisting of cam, spring, levers, operating together and upon the shipper cord.

141. ARRANGEMENT FOR SUPPLYING AIR TO THE FURNACES OF STEAM BOILERS FROM THE WHEEL-HOUSES OF STEAMERS; Louis Brandt, Indianola, Texas.

Claim—Supplying air under pressure to the furnace or furnaces of steamers, by means of the paddle-wheel and the peculiar curved pipe with water escape passage leading from the casing or housing of the same to the fire, or under the grates of the furnaces, as set forth.

142. CORN SHELLERS; B. Bridendolph, Clear Spring, Maryland.

Claim—The differential feeding and shelling screw, constructed as described, in combination with the spout or trunk and face wheel, arranged and operating together in the manner described.

143. WAGON BRAKES; Robert D. Brown, Prattsburgh, New York.

Claim—The combination and arrangement of the brake mechanism, lever, and connecting rod, when the latter is attached directly to the front axle, so as to be operated by the backward movement of the front truck; the said movement being allowed by the slot in the reach or coupling bar, and the roller in the bolster.

144. SKIRT SUPPORTERS; Henry F. Brown, Chagrin Falls, Ohio.

Claim—An improvement in the supporter aforesaid, by connecting the hoops or bands by a clasp or inflexible joint.

145. COAL-SIFTERS; Joseph P. Buckland, Chicopee Falls, Massachusetts.

Claim—1st, A dumping or tipping sieve provided with a movable tail-piece or gate, so arranged that the tipping or slanting of the sieve causes the opening of the end or side of the same, for the free passage of the coal or other substance sifted. 2d, A combination of the scrolls and cams with the sieve, arranged in the manner described.

146. BREECH-LOADING FIRE ARMS; Bethel Burton, Brooklyn, New York.

Claim—The construction and relative arrangement of the breech-supporter with the sliding breech, sectional screw, guide slot, and pin, as set forth.

147. HOLD-BACKS; R. W. Carrier, Sherburne, New York.

Claim—The combination and arrangement of the open hold-back loop or eye, pivoted lever stop bar, which has an extension or heel on its lower end, and the flat spring, as set forth.

[This invention relates to an improvement in the metal loops or eyes that are attached to the thills of vehicles, to receive the straps of the harness by which the vehicle is held back in descending hills. The invention consists in having the loops or eyes provided with yielding bars or studs at their front sides, so that the straps may detach themselves as the horse passes out of the thills. The object of the invention is to allow the horse to be readily detached from the vehicle when necessary, and not permit the hold-back straps, as hitherto, to form a positive connexion with the thills, which is a fruitful source of accident.]

148. GATE; S. W. Chamberlain, Three Oaks, Michigan.

Claim—The arrangement and combination of the gates, posts, arms, links, and levers, in connexion with the cords, constructed as set forth.

149. ATTACHING HANDLES TO CUTLERY; Mathew Chapman, Greenfield, Massachusetts.

Claim—Securing handles to cutlery and other tools or implements, by having a screw thread formed on the tangs, and provided with plane longitudinal surfaces in connexion with the cylinder or nut fitted in the handle, and hammered or compressed to fit the screw and its plane surfaces, as set forth.

150. CONSTRUCTION OF VAULT LIGHTS; John B. Cornell, City of New York.

Claim—Producing an improved illuminating plate by the process of combining the illuminating and metallic portions of said plate with each other, in the manner set forth.

151. STEAM VALVES; C. W. Corr, Carlinville, Illinois.

Claim—1st, Providing the extremity of the driving shaft within the steam chest, with a slot to receive the head of the valve stem, and permit the self-adjustment of said head within the slot. 2d, The arrangement of the screw threads upon the valve and valve stem, so that the valve will adjust itself if the friction becomes too great.

152. APPARATUS FOR PRESERVING GRAIN; Louis Michel François Doyere, Paris, France; patented in France, March 28, 1854.

Claim—The method of constructing or arranging air-tight chambers or granaries for the preservation of corn and other grain, as described.

153. STONE-LOADING WAGONS; Nathaniel Drake, Newton, New Jersey.

Claim—The employment or use of the shaft with one or more drums placed loosely on it—the shaft and drums being provided with ratchets, in combination with the pawls and the adjustable bar, provided with the pulleys, the whole being applied to a mounted frame, and arranged as set forth.

154. ANTI-FRICTION BOXES; Joseph L. Dutton, Sr., Philadelphia, Pennsylvania.

Claim—Interposing between a revolving and stationary surface any convenient number of beveled antifriction rollers, so formed that the portion of each roller on which the revolving surface bears shall be larger in diameter than the portion or portions of the roller which bear on the stationary plate.

155. PLATFORM SCALES; Thaddeus Fairbanks, St. Johnsbury, Vermont.

Claim—The arrangement and application of the yoke stirrups, their concave steps or bearings, and the pivots of the two multiplying and transmitting levers, as specified. Also, combining with the rod and the yoke applied thereto, as described, the cap or bonnet, being for the purpose specified.

156. PLATFORM SCALES; Thaddeus Fairbanks, St. Johnsbury, Vermont.

Claim—Supporting the fulcrum of a transmitting lever by the platform or an extension therefrom, as specified. Also, the combination of the rocker block with the stirrup link, and the bearing pins or knife edges of the connected levers, as described. Also, constructing the platform frame with the passages through each of its end timbers, and for the reception of the inferior arms of the multiplying levers. Also, providing such platform with loop passages leading downward out of the lever passages made in the end timbers, as described.

157. PIPE MOULDING; John Firth and John Ingham, Phillipsburgh, New Jersey.

Claim—1st, The employment or use of the flexible elastic ring, in connexion with the body pattern, flasks, and bottom plate, for the purpose specified. 2d, Blackwashing the moulds by means of a brush, or an equivalent device, supplied with the blackwash and passed through the moulds, as set forth.

158. SCREW TAPS; Wm. and Robert Foster, City of New York.

Claim—The combination of the oblique-backed taps and slotted collar, with the tapering or conical stock, so that on turning the collar the cutting threads of the taps will be released from the nut, and thus allow the tool to be withdrawn.

159. BELT-FASTENINGS; William Frazier, Hartford, Connecticut.

Claim—The arrangement of duplicate plates, A B, of raw hide, or other flexible or suitable material, and in providing one (or both) of the plates with metallic hooks, which hooks are made to pass through the perforations in the belt, and in the plates, A or B, to connect and hold the two ends of the belt together (in contradistinction for the use of the metallic plates, screws, lace-leather, &c).

160. MANUFACTURE OF CAOUTCHOUC BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—The method described of manufacturing belts or bands of india rubber or gutta percha, consisting in placing them in contact with sheets or strips of paper or cloth, having a smooth enameled or polished surface, and then heating them, as described.

161. STEAM EXCAVATORS; W. G. Goodale and R. L. T. Marsh, Centralia, Illinois.

Claim—1st, The combination, with a locomotive steam engine, of an earth elevator and suitable earth receptacles, so that the machine may be moved by its own power, under the guidance of an attendant, to the spot to be excavated; then be made to load itself and transport the load to the desired place for discharge, in the manner set forth. 2d, The combination with an excavating machine, made as set forth, of a railroad track, as shown, with or without the turn-tables.

162. SKIRT-SUPPORTERS; D. B. Hale, City of New York.

Claim—The waist, in combination with the extension expanded by the insertion of hoops, having their ends connected by tying them and forming entire circles, in the manner set forth.

163. CHAIRS FOR RAILROADS; Hayward A. Harvey, City of New York.

Claim—Forming the chair with lips extending over the web or base of the rails, and with a groove, or equivalent reception for a wedge—but this I only claim when combined with a wedge to be driven across the longitudinal plane of the rails, and passing under the base of the two rails to force and hold them up against the lips of the chair, and to form a base or rest for the base of the ends of the two sections of rails to rest on, as specified.

164. SHOES AND GAITERS; Alexander Hay, Philadelphia, Pennsylvania.

Claim—Inserting in the shoe or gaiter, at the points where it is to be fastened, a piece or pieces of elastic rubber cloth, for the purpose of fastening the shoe or gaiter with hooks and eyes, or buttons, or buckles, as described, and thereby dispensing with shoe strings.

165. DOOR-FASTENER; George V. Hazard, Torrey, New York.

Claim—The part, A, constructed and arranged as set forth.

166. RAT-TRAP; Simpson S. Henderson, Oxford, Ohio.

Claim—The combination of the springs with cone spools, catch, detent, and bait wire, forming the trigger and striker, the whole operating in the manner set forth.

167. CLOTHES-DRYER; D. K. Kickok, Morrisville, Vermont.

Claim—The internally-grooved hub and spring catch, in combination with hollow-headed shaft, headed pin, and securing cord, as set forth, when arranged with hub, braces, arms, and cord.

168. HYDRO-CARBON VAPOR APPARATUS; Levi L. Hill, Greenport, New York.

Claim—The combination, with a vaporizing vessel, of the bellows, air receiver, and eduction pipe, as shown, or in an equivalent manner.

169. STUMP EXTRACTORS; Edwin Hosmer, Bedford, Massachusetts.

Claim—The improved lever and hook stump extractor, as constructed, with the combination of the holding tongue and its supporter, and with each united by a universal joint, in manner specified.

170. MACHINE FOR CUTTING PAPER; Thomas W. Houchin, Worcester, Massachusetts.

Claim—The combination and arrangement of the knife, slides, and connecting bar, with coupling arms, eccentrics, and shaft, as set forth.

171. IRON PLATE JAIL; Enoch Jacobs, Cincinnati, Ohio.

Claim—In the construction of jails and prison houses, the improved iron walls for the same, consisting of the following parts, arranged and united as set forth, to wit: the entire wall plates, A, having their edges closely abutting the joint plates, united to and uniting the plates, A, by rivets, which have their riveted ends inwards, and counter-sunk to the depth of the thickness of the plates, A, in the manner set forth.

172. GRAVING DOCKS; Wm. A. Kenrick and George H. Whitcher, Boston, Massachusetts.

Claim—The floating dock and the stationary receiving basin or tank, in combination and as furnished, not only with one or more connexion pipes and gates for the discharge of water from the dock into the tank, or vice-versa, but with one or more passages and gates arranged in the tank, so as to either discharge water therefrom into the sea, or admit it to pass from the sea into the tank. Also, the elevating slide, in combination with a connexion pipe of the dock, and a deep opening made in the tank, the said slide being arranged therewith, and connected with the dock, as specified.

173. CAR TRUCKS; Henry Kipple and Jacob D. Bullock, Philadelphia, Pennsylvania.

Claim—The bolster and platform, with the intervening springs of any suitable construction, in combination with the inclined links, their sockets, and the pins, arranged on the truck, as set forth.

174. PIANO-FORTES; John G. Kunze, City of New York.

Claim—1st, Supporting the bridge on columns or distance pieces, to admit any number of braces for the hitch plate, between the strings and the top of the sounding-board, and likewise to admit of a greater vibration of the sounding-board, in the manner described. 2d, The arrangement of additional braces to the hitch plate, situated between the strings and the top of the sounding-board, and connecting said braces with the braces or the wooden truss-work situated between the frame, in the manner set forth. 3d, The application of a bottom sounding-board when in connexion with a lower metallic frame or hitch plate covered with strings, in the manner described. 4th, The elastic spring brace to connect the two sounding-boards together, for the purpose described. 5th, The arrangement of the strings in two rows, with the use of a curved hammer line, in piano-fortes where the action strikes the strings from above downwards.

175. BREECH-LOADING FIRE ARMS; Richard S. Lawrence, Hartford, Connecticut.

Claim—1st, The combination of the detachable plate, between the barrel and the sliding breech, with the expanding ring, as set forth. 2d, In combination with the sliding breech and plates, I claim the hollow nipple situated in the centre of the gas chamber, and projecting forward nearly or quite to the face of the breech, as set forth.

[This invention relates to that description of breech-loading fire arms which have what is commonly known as the "sliding breech." It consists in making the sliding breech of two pieces—one of which pieces, constituting the entire back of the breech, has in it a cylindrical cavity larger than the bore of the barrel, and the other of which, constituting the entire face, has a counter-sunk projection which enters and fits the said cavity in such a manner that the said projection combines with the said cavity to form a gas chamber in the rear of, and of larger bore than the barrel, and communicating with the barrel by a suitable opening in the front part of the breech, which admits the gases into the said chamber at each discharge, to force apart the two pieces of the breech, and cause the front pieces to form a perfect gas-tight joint with the rear end of the barrel; and thus, while preventing any loss of the explosive force, preventing the corrosion of the face of the breech, and permitting it to slide with perfect freedom after frequently and quickly repeated firing. It further consists in the employment, in combination with the so constructed breech, of a hollow cone situated in the centre of the cavity of the rear portion of the breech, and projecting nearly even with the front face of the breech, for the purpose of communicating the fire from the cap or other priming to the cartridge or charge in an exact line with the centre of the bore of the barrel.]

176. STAVE MACHINES; James Little, Evansville, Indiana.

Claim—The adjustable bed, in combination with the rod and lever, arranged to operate as set forth.

177. WATER TRAPS; James A. Lowe, City of New York.

Claim—The water trap shown, when cast without a seam (in lead or composition).

178. FERTILIZERS; James J. Mapes, Newark, New Jersey.

Claim—The production of the fertilizers for soils, by the combination of dried blood with the compound which I have herein specified as my improved superphosphate of lime, or any equivalent therefor, substantially the same.

179. CLASP FOR HITCHING STRAPS; M. R. Margerum and T. P. Marshall, Trenton, New Jersey.

Claim—The arrangement of the hole and the key, in combination with the sliding part for fastening hitching straps, as described.

180. WOOD SCREWS; Charles Millar, Utica, New York.

Claim—The construction of wood screws having a shank, or that portion of the wire lying between the thread and the head of the screw reduced in its diameter, so that, without any enlargement of the orifice beyond that made by the stem, the screw may be driven home without increase of friction at the shank, and without injury to the screw or to the hold thereof upon the fibres of the wood, as described.

181. WASHERS; George Miller and Caleb M. Andrews, Providence, Rhode Island.

Claim—A washer, constructed of a leather strip wound in coil form, and with or without the interposition of other substances between its convolutions, as set forth.

[This invention consists in forming the washers by winding leather strips of any convenient width in coil form, whereby the sides or faces of the washers present the grain or fibre of the leather endwise to the running or working surfaces of articles to which they are applied. The convolutions of the leather may be connected by cement; and, in certain cases where necessary, soft metal plates or other suitable substance may be interposed between the convolutions in order to protect the leather from wear.]

182. SHUTTLES FOR SEWING MACHINES; G. W. Mitchell, Jackson, Tennessee.

Claim—The shuttle, formed with an open cavity through it in a transverse direction to its movement, with the bobbin to fit the cavity, the heads of the bobbin forming a part of the sides of the shuttle, and being kept in position by the sides of the shuttle race or carrier, as described.

183. PLATFORM SCALES; Amos B. Morey, St. Louis, Missouri.

Claim—The specific arrangement of the braces with the lever and the head, as described.

184. NAIL PLATE-FEEDER; John Newell, Lowell, Massachusetts.

Claim—1st, In combination with a magazine for containing a pile of plates, an automatic driver that takes the under plate of the pile, and feeds it up toward the cutters in regular succession, as described. 2d, In combination with the automatic driver, the geared hub and segment, and hinged lever, R, for turning and moving the nail plate to the driver and to the cutters, as described. 3d, In combination with the driver or the carriage to which it is connected, the lever, S, with its several connected parts, for throwing out and holding out of gear the feeding devices, while the driver is in the act of bringing up a fresh nail plate. 4th, In

combination with the feeding shaft and its grooves, the pivoted switch on the carriage, for the purpose of giving said carriage a rapid rotating and partial advanced motion, and a slow feed motion.

185. SKELETON SKIRTS; Cæsar Neumann, City of New York.

Claim—The spring joint or hinge, arranged as specified, by which the hoops can be contracted and expanded, in the manner set forth.

186. PRESERVE CANS; Carlton Newman, Birmingham, Pennsylvania.

Claim—The use of the loose or detached elastic band, when used in connexion with the flaring rim or lid, rib or ridge, and groove, in the neck of the jar, or the equivalents of said rim, ridge, and groove, arranged as described.

187. COTTON GINS; D. G. Olmsted, Vicksburgh, Mississippi.

Claim—1st, Feeding the cotton into the roll box through a hulling grate, so as to exclude the principal bulls and trash, while the seed cotton is admitted. 2d, The projections at the intersection of the ribs of the ginning grate, and extension, for the purpose of directing the cotton past the seed space at the lower edge of the hulling grate, in combination with said grate. 3d, The arrangement of the air-directing partition, constructed as described, in combination with the hatchel cylinder, for the purpose specified, at the same time disclaiming its use in any other manner or connexion. 4th, The extensions, when arranged as continuations of the brush wings, around the ends or heads of the brush cylinder, for the purpose specified—while I disclaim the use of wings or fans on the ends of the brush cylinder unconnected with the brush wings.

188. PIPE COUPLINGS; Charles G. Page and Ralph J. Falconer, Washington City, D. C.

Claim—Combining the lateral or transverse movement of the male and female sections with an endwise movement, to effect the tightening of said sections, as set forth.

189. DOOR BOLTS; Charles Grafton Page, Washington City, D. C.

Claim—The locking of bolts, when bolted or shut, by means of rotary handles moving with the bolts, and operating upon the principles set forth.

190. MANUFACTURE OF RUBBER ARTICLES; Du Bois D. Parmelee, Salem, Assignor to John A. Greene, Beverly, Massachusetts.

Claim—The employment, in the manufacture of india rubber sheets, whether combined or not with cloth, and when the same are to be treated in the cold way to effect the change, as described, on either side of the tank containing the hermizing solution, of a feeding mechanism, so arranged and operated that the sheet may be fed in and out of the tank at a uniform rate, and free from injurious handling and draft or strain, in the manner set forth.

191. MACHINE FOR FORMING HUBS; William Patterson, Constantine, Michigan.

Claim—In combination with the swivel nut having a yielding or spring seat, the adjustable collar, and cutter shaft for causing the cutter to form a shoulder in the hub, in a plane parallel to the end of the hub, while the cutter is carried and fed by an inclined screw shaft, as described. Also, the combination of the guiding spring bar and its adjusting screws with the slide, centre disc, and cutter shaft, for the purpose of boring out the interior of the hub and cutting off the ends of the spokes, and thereby prevent the latter from resting and pressing unequally on the box or on the exposed part of the axle.

192. HEATING APPARATUS; Calvin Pepper, Albany, New York.

Claim—The use of fine silicious sand for radiating heat according to the application thereof, as described, the radiation being principally from the sand, and the radiation from the sand coming from between the meshes of the fine wire gauze screen, or the openings of minutely perforated metal, or other solid substance, the metallic gauze or perforated metal being used for the purpose of retaining the sand while admitting radiation through its meshes, and the sand being heated by the fuel of wood, coal, gas, burning fluid, or other fuel, or from hot metal, hot air, hot water, or steam in stoves, tubes, conductors, or other heating apparatus, substantially as described, and subject to the disclaimer and exceptions as stated.

193. STOVES; Albion Ransom, Albany, New York.

Claim—The application to and use with sheet or thin metal stoves, of an independent hood flue formed and fitted for attachment to such stoves, as described, and for the purposes set forth.

194. RAILS FOR STREET RAILROADS; Abraham Reese, Pittsburgh, Pennsylvania.

Claim—Making iron rails for street railroads of the shape substantially as described, having on each side a head or projection at one edge of the rail, with a flat base extending from the projection or head to the other side, both sides or faces being finished alike, so that the rail may be used either side up, and reversed when one side is worn out.

195. GOLD-WASHER; Celestin Ringel, San Francisco, California.

Claim—The combination of a water-wheel with a separating or reducing machine into one apparatus, by using the inner space of a wheel partly or wholly inclosed as a receiver, dispensing in this manner with couplings or connexions, and with a second vessel or receiver, which would have to be set in motion by the water-wheel.

196. STEREOSCOPIC APPARATUS; T. C. Roche, City of New York.

Claim—1st, The employment of a skeleton wheel, as described, for the purpose of bringing the pictures before the eye glasses. 2d, Placing the pictures together back to back, and so that one is upright when the other is upside down. 3d, In combination with the chain of pictures, I claim the arrangement of the sliding partition and door, on the side and near to the bottom of the box, as set forth.

197. BREECH-LOADING FIRE ARMS; J. Hunter Sears, Brantford, Canada West.

Claim—Combining and applying the hinged breech-piece and the breech screw, as specified, so that the force applied to a lever attached to the screw may serve to first withdraw the screw, and afterwards throw out the breech-piece.

198. WORKING BUTTER; Josiah Seymour, Coventry, New York.

Claim—The construction and arrangement of the tray to retain the fluids when desired, in washing and working over butter. Also, the manner of securing the tray to the platform or table, so as to be easily tipped up to drain off the fluids in cleansing, the detachable arch frame, and rounded wedged-shaped butter-worker for spreading thin while salting, all in combination, as specified.

199. SHIPS' STOVES; George W. Slater, New Haven, Connecticut.

Claim—Forming the joints of the thimbles and sockets, attached respectively to the swinging flue, stove, and stationary flue, as set forth.

200. SURFACE CONDENSERS FOR STEAM ENGINES; Ananias Smith, Niagara Falls, New York.

Claim—1st, The employment, in connexion with a steam engine and its boiler, of a revolving bucket wheel, arranged to receive the exhaust steam from the engine, and made to rotate in a reverse direction to its issues in a cylinder or vessel containing water, from which the boiler of the engine is fed, the exhaust steam being condensed by direct impingement with and adding to said feed water. 2d, The combination with the revolving bucket or wheel constructed to receive the exhaust steam from the engine and cylinder, or vessel containing the condensing liquid or feed water in which the wheel rotates, and by direct contact with which water the exhaust steam is condensed, in the manner described, of a surface cooling apparatus, formed by providing said feed water vessel with a jacket or tubes, or their equivalents, through which a cooling liquid is made to pass or circulate, free from admixture with the water in the vessel, that directly effects the condensation of the steam.

201. PIPE-NIPPERS; George Smith, City of New York.

Claim—The combination with the slotted lever of the movable claw, grooved pin, and holding spring, so that the claw may be readily removed from one side of the lever to the other, thus forming a right or left-handed instrument at pleasure, as set forth.

202. LEVER ESCAPEMENT FOR TIME-PIECES; Nathan Spicer, St. Paul, Minnesota.

Claim—The combination of the two sets of teeth on the escape wheel and the single pair of pallets, or their equivalent, with two or more forks on the lever, operating upon and operated upon by a single pin or cylinder attached to the balance, operating as set forth.

203. GRAND PIANOS; Henry Steinway, City of New York.

Claim—The arrangement of the strings of the lower notes, and those of the higher notes of a grand piano-forte, as described.

204. DEVICE FOR FEEDING THE BOLT IN SHINGLE MACHINES; Oren Stoddard, Busti, New York.

Claim—The ratchets attached to the feed shafts, provided each with alternate long and short teeth, and operated by the pawls and slide from the knife-gate or frame, in the manner specified.

205. INVALID COUCH; C. L. Maillant, City of New York.

Claim—The method of constructing an invalid couch, arranged in the manner set forth.

206. MAST-SCRAPER; Robert N. Tate, New London, Connecticut.

Claim—An implement or tool, composed of a steel plate, provided with one or more concave edges, and attached to a suitable tang or handle.

207. SEWING MACHINES; Joseph Thorne, City of New York.

Claim—The specific arrangement of parts described, for giving the appropriate motions to the needle-bar and to the shuttle-driver.

208. THREAD TENSIONS FOR SEWING MACHINES; E. L. Pratt, Philadelphia, Pennsylvania.

Claim—Separating and holding the coil at the openings through which the thread passes in and out from between it and its fellow or support, by means of the strips, or their substantial equivalents, for the purpose of allowing a free passage of the said thread without causing friction on the openings, and for the better adjusting or changing the thread whilst the spring remains at the proper working tension, as described.

209. REPEATING PISTOLS; G. Tigneres, Covington, Louisiana.

Claim—The rack and dog, in combination with a sliding trigger, arranged and operated as set forth. Also, in combination with the plate, the arm, the bar, and the plate, arranged and actuated on as described.

210. GRIDIRON; John G. Treadwell, Albany, New York.

Claim—The employment of the gauze wire screen, or its equivalent, the gridiron, and the cover, when the same are used as specified.

211. ATTACHING SKATES TO BOOTS; Thomas Spur Whitman, City of New York.

Claim—Uniting the skate iron to the sole of the boot or shoe, in the manner stated.

212. ARTIFICIAL FUEL; H. Wilverth, Caseyville, Kentucky.

Claim—A composition formed by mixing the mentioned ingredients together, in the proportions and in the manner specified, for the purpose set forth.

213. SKATE FASTENINGS; Edward Wirths, City of New York.

Claim—The mode of attaching the side pieces to the skate, for the purpose of adapting the same to feet of different sizes, when the same shall be arranged and operated as set forth.

214. MACHINES FOR FEEDING-UP, CUTTING, AND PASTING DIRECTIONS ON NEWSPAPERS, &c.; Robert W. Wright, New Haven, Connecticut.

Claim—In combination with a strip or fillet of paper, on which the names or addresses are equi-distantly arranged, an intermittent feed motion, and a pasting, cutting, and carrying device, working automatically together, as described.

215. PIPE-CUTTER; James R. Brown, Boston, Assignor to self and J. Henry Norton, Medford, Massachusetts.

Claim—The pipe-cutting instrument, as constructed with the hinged and recessed jaws, the movable cutter, the adjusting screw, and the spring shank or shanks, extending from the jaws, and having a connexion hook, or its equivalent, as specified.

216. PRINTING PRESSES; Thomas H. Burridge, Assignor to self and Thomas W. Ustick, St. Louis, Missouri.

Claim—The direct application of steam power to the type table of a printing press, and in causing the same piston that actuates the said table to arrest the momentum thereof, as described.

217. COTTON-PACKERS; Lewis S. Chichester, Assignor to H. G. Evans, City of New York.

Claim—Pressing cotton and other fibrous substances into sacks, by placing the same on a hollow cylinder, fitted over an aperture of corresponding diameter in the flooring, and having clamps bearing or pressing against the sack on the cylinder, and so arranged as to allow the sack to render or give over the cylinder under the pressure of a plunger, while pressing the substance into the sack.

218. SHIFTING TOPS FOR WAGONS; Homer H. Dikeman, Assignor to Ira Dikeman & Son, New Haven, Conn.

Claim—The shifting slide or curtain rail, in combination with the jointed bows, constructed as described.

219. FERTILIZERS; W. D. Hall, Assignor to the Quinnissiac Company, Hamden, Connecticut.

Claim—Preparing concentrated artificial manure by boiling fish in common fresh water, until the whole

is thoroughly cooked, then removing it from the vessel, and when sufficiently drained, sprinkling on it from one to three per cent. (usually about two per cent.) by weight of sulphuric acid, mixing thoroughly, and drying by solar or artificial heat, when the whole is effected substantially in the manner and by the process described.

220. INDIA RUBBER BELTING; B. F. Lee, Assignor to the New York Rubber Co., City of New York.

Claim—The combination belting or banding specified, and consisting of two or more thicknesses or layers of fibrous material, cemented and quilted together, as set forth.

221. PIANO-FORTE ACTION; Frederick Mathushek, Assignor to self and Wellington Wells, City of New York.

Claim—The combination of the auxiliary jack, the regulating screws, the improved hammer butt, and improved arrangement of the spiral spring, with the French action, arranged as set forth.

222. MANUFACTURE OF INDIA RUBBER HOLLOW MOULDED ARTICLES; D. D. Parmelee, Salem, Assignor to J. A. Greene, Beverly, Massachusetts.

Claim—Making hollow articles of india rubber, or its equivalent, or their compounds, when the same are to be treated in the cold way, after moulding to effect the change, as described, by shaping the articles in moulds from bags formed of such rubber, and exhausting the air from between said moulds and the bags.

223. BOOT STRAP-FASTENER; Sylvanus Walker, Boston, Assignor to D. W. Smith, Somerville, Massachusetts.

Claim—The described boot strap-fastener, consisting of the plate or shield, and hollow rivets or eyelets, as described.

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224. VISE AND SAW-SET; Norman Allen, Unionville, Connecticut.

Claim—The vise formed of the bars, A A, with jaws attached, the movable bar being actuated by the treadle, rod, C, and toggle, or their equivalents, in combination with the saw-set formed of the bar or bed, E, attached to the vise by the rod, F, and provided with the beveled plate, gauge, and adjustable centre, as set forth.

225. STRAW-CUTTERS; Wm. H. Baker, Daniel Dean, and B. L. Fetherolf, Tamaqua, Pennsylvania.

Claim—1st, The double-edged reciprocating knife, in connexion with the bed, arranged to operate as set forth. 2d, The arrangement of the eccentric, yoke, slide, lever frame, and bars, as described, for operating conjointly the feed bar and pressure bed. 3d, The eccentric plate placed on the shaft, when used in connexion with the slide to control its longitudinal movement, for the purpose set forth.

226. MACHINES FOR PULVERIZING QUARTZ; William Banham, San Francisco, California.

Claim—The circular troughs, constructed as described, in combination with the drags at the extremities of the radial arms, constructed in the manner set forth.

227. VENEERING MACHINES; R. D. Bartlett, Bangor, Maine.

Claim—The application of the throat gauge to the main and secondary cutters, so that both the gauge and secondary cutters can be turned upward away from the log, under circumstances and for the purpose or objects as set forth.

228. MAGNETO-ELECTRIC MACHINE; G. W. Beardslee, Flushing, New York.

Claim—The mode of operation of the pole-changer, by which the current is made to travel in the same direction, as described.

229. MAGNETO-ELECTRIC MACHINE; G. W. Beardslee, Flushing, New York.

Claim—The compound magnet described, consisting of radial poles, arranged about a common centre, and connected together at their inner ends, as described. Also, forming such a compound magnet, with radial poles connected at their inner ends, by cutting out the radial poles and connecting rings from a single plate, as specified. Also, in combination with rotating magnets, the insulated rings to which the terminal wires of the helices are connected, as described.

230. SEEDING MACHINES; James Bouton, Macon City, Missouri.

Claim—The arrangement of the wheels, pipes, covers, springs, and the yielding beam; also, the arrangement of the valve in the hopper, in the manner described.

231. MANUFACTURE OF HOES; Samuel Boyd, Brooklyn, New York.

Claim—The combination with the drop and anvil of the drop opening and mandrel, so that after the drop has given its blow, it will hold the hoe in place, and allow the mandrel to be passed through it into the hoe, to form and finish the eye thereof, as described.

232. GUIDES FOR SEWING MACHINES; O. G. Brady, City of New York.

Claim—The combination of the presser, having its sole formed with a curve, a grooved toe, and a recess, as described, and the curved guide tube, arranged relatively to the curved edge and toe of the presser, as described.

233. COTTON SEED PLANTERS; R. M. Brooks, Greenville, Georgia.

Claim—The arrangement of the wheels, the seed-box, the handles, the bar, the braces, L, coulter or opener, covers, arm, and brace, W, as described.

234. PLOUGHS; R. M. Brooks, Greenville, Georgia.

Claim—The arrangement of beam, screw foot, notch, plough hoe, opening, P, mould-boards, openings, U, nuts, and holes, constructed as described.

235. TOP PROPS FOR CARRIAGES; George Cook and H. I. Kimball, New Haven, Connecticut.

Claim—The combination of the thimble or pipe with the screw bolt or standard, and the joint bars, constructed as described.

236. REGISTER FOR RAILROAD CARS; S. F. Covington, Indianapolis, Indiana.

Claim—The indicator, when operated in connexion with the telegraph instrument, or its equivalent, using the Roman numerals, or their equivalents, and operating the same as set forth.

237. DITCHING MACHINES; Isaac R. Crane, Warsaw, Missouri.

Claim—The arrangement of the plough with the frame, and the scoop and elevator, and the described arrangement of devices for operating the said plough, in the manner described. Also, the arrangement of

devices whereby the scoop and elevator of my machine is lowered in and raised out of the ditch, in the manner described. Also, the arrangement of the guide wheel with the frame, and with the arrangement of devices for operating the said wheel, as described.

238. MACHINE FOR TURNING IRREGULAR FORMS; L. B. Miller, Newark, New Jersey, Assignor to A. D. Crane, Boston, Massachusetts, D. F. Tompkins, L. B. Miller, and C. T. Tompkins, Newark, and D. Holsman, Passaic, New Jersey.

Claim—1st, The double disc cutter head, constructed in the manner described. 2d, The consolidation of the separate cams into a solid former or consolidated cam, and the use of such consolidated cam or former, in combination with the said Crane's lathe. 3d, The use of the levers, formed and adjusted in the cutter's head, as described.

239. RAILROAD CAR COUPLINGS; J. G. Goshon, Assignor to self, H. Ruby, John Wunderlich, and H. R. Ruby, Shippensburg, Pennsylvania.

Claim—The longitudinal moving shaft, in combination with the spring, bolt, arm, and projection, as set forth.

240. LOCK; G. W. Dana, Durand, Illinois.

Claim—1st, The employment or use of a series of spindles, G K, provided with slots or recesses, and with lettered caps connected by catches, the spindles being arranged directly with the bolts, as with C, or indirectly, by means of wheel, F as with B, either or both, for the purpose set forth. 2d, The slide bar, provided with the projections, arranged relatively with the slots and connected with the guard wheel, as shown, in connexion with the wheel, F, and spindles, G, arranged to operate as set forth.

241. CLOTH-HOLDER IN NEEDLE-WORK; Newell Daniels, Milford, Massachusetts.

Claim—A ladies' work-holder, to hold the work by the action of the piece towards and in connexion with the solid part of the frame, constructed and operating in the manner described.

242. SLEEPING CHAIRS FOR RAILROAD CARS; John Danner, Canton, Ohio.

Claim—1st, The limb-supporting device, in combination with the seats, constructed as described. 2d, The combination with the seats and frames of the backs, folding head rests, and slotted pieces, arranged and operating in relation to, and in combination with, the limb-supporting device, as set forth.

243. WASHING MACHINE; L. A. Dole, Salem, Ohio.

Claim—The arrangement consisting of the tub, rubber, hinged rubber, slotted arms, lever frame, and hinged inclined links, in the manner described.

244. CLARIFYING CANE JUICE; Francisco Domenech, Ponce, Island of Puerto Rico; patented in the Island of Puerto Rico, August 17, 1858.

Claim—The method of determining the amount of lime necessary to be added to the raw juice, to defecate the same, by the employment of the volumetric method, as set forth.

245. APPARATUSES FOR EVAPORATING SUGAR JUICES; Eugene Duchamp, St. Martinsville, Louisiana.

Claim—1st, The arrangement of a vertical boiler in front of the furnace, having a funnel, spiral conveyor, and cone, when the whole are combined for the purpose and in the manner set forth. 2d, In combination with the above vertical boiler, the semi-cylindrical concentrating boiler, when the same is constructed and arranged in the manner specified.

246. BED BOTTOM; A. M. Dye, Clinton, Illinois.

Claim—The attaching of the traverse bars of the frame to the side strips, by means of the dovetail slides, and sockets or guides, provided with the screws, and attaching the bars of the frame to the side strips, by means of the set-screws, as specified.

247. AMALGAMATOR; Lucius Eddleblute, Garden Valley, California.

Claim—The combination of the bars with the inclined or bevel slats, and inclined top and bottom, as shown, so that the water has an easy access, and in its fall first strikes the edges of the bars, and thus avoids the washing of the quicksilver, as set forth.

248. BEDSTEAD; Seraphin Espach, Cincinnati, Ohio.

Claim—The described arrangement and combination of parts consisting essentially of the foundation, and its springs, posts, rails, hooks, and their sockets, the braces, and their adjusting screw, and the lattice work-head and foot-boards.

249. EXTENSION SEATS FOR CARRIAGES; Francis J. Flowers, Rahway, New Jersey.

Claim—1st, The operation and combination of the raising bar, or its equivalent, with the parts A and C. 2d, The combination of the recess with the legs. 2d, Forming the joints, in combination with the boot, for the purpose set forth.

250. CARVING FORK; Henry Garbanati, Brooklyn, New York.

Claim—The permanent spur guard and the fulcrum guard, in combination with a carving fork, as described.

251. MANUFACTURE OF INDIA RUBBER BELTING; Dennis C. Gately, Newtown, Connecticut.

Claim—The improvement in the manufacture of machine belting or banding, composed wholly or in part of india rubber or gutta percha, the same consisting in rolling or winding up the belt or band with any suitable non-adhesive substance or composition interposed between its folds or layers, and then heating it in the manner and for the purposes described.

252. CULTIVATORS; Henry Gilliard, Mount Hope, Wisconsin.

Claim—The arrangement of the permanent circles and jointed bars, constructed for joint operation, as set forth.

253. HARVESTERS; John Gore, Brattleboro', Vermont.

Claim—The use of lever, constructed as described, in combination with the tapering draw bar for elevating the cutting apparatus of the harvester, in the manner described.

254. SELF-ADJUSTING COUNTER BRACES OF TRUSS BRIDGES; John Gray, Nashville, Tennessee.

Claim—The application, to counter braces in truss bridges, of a socket at the top, a heel and key at the bottom, by which the counter braces in truss bridges are made self-tightening and adjusting, as described.

255. MACHINE FOR PLANING CURVED SURFACES; J. P. Grosvenor, Lowell, Massachusetts.

Claim—The employment or use of the adjustable or yielding feed rollers, when combined with a bearing

roller or a proper bearing surface, and arranged relatively with each other, as described, to admit of the feeding of circular, oval, and serpentine forms to the cutters. Also, placing the rollers in an adjustable frame or box, e, fitted in an adjustable box, x, and used in connexion with the elastic bars, or their equivalent, and the bearing rollers, whereby the frame or pattern may be properly adjusted and retained in proper position between the rollers while being acted upon by the cutters.

256. CIRCULAR FORMS; Joseph A. Grunwald, City of New York; patented in France, September 20, 1859.

Claim—1st, The manner of weaving in a horizontal circular plane by means of two or more wefts, and an arrangement of warps placed alternately above and below the weft threads, arranged in the manner described. 2d, The arrangement of the weft bobbin carriage, in combination with the arrangement of regulating the tension on the weft thread, as described. 3d, The arrangement and construction of the tension levers, for the purpose of maintaining the tension of the warp threads as well as the friction against the warp bobbins, acting together in the manner set forth. 4th, The arrangement of the serrated pulley, in combination with the rollers, operating together in the manner described, and for the purpose of delivering the manufactured article as fast as finished and at a regular tension. 5th, The arrangement of the disengaging gear, constructed as described, and for the purpose of throwing the loom out of gear as soon as one of the weft threads break, the same being operated by a lever attached to the weft bobbin carriage, and acted upon by the weft thread, in the manner set forth.

257. SEWING MACHINES; James Harrison, Jr., City of New York.

Claim—1st, The rotary needle guide disc, constructed and operated in the manner described. 2d, The arrangement of the following devices for holding and operating the shuttle, viz: the arm, the revolving button, slotted to receive the arm, the shuttle case, rod, and its head, spring, and legs, all constructed as described. 3d, Constructing the shuttle with the ridge, and holes, and thread space, as described. 4th, Inserting the lever bar in the needle bar, and operating it as described.

258. GANG PLOUGHS; T. S. Heptinstall, Mendota, Illinois.

Claim—The arrangement of the wheels, shafts, spindle, triangle, rod, lever pole, regulator, and rollers, as described.

259. PROCESS FOR MAKING SULPHURIC ACID; Homer Holland, Westfield, Massachusetts.

Claim—The generation of sulphuric acid by treating sulphides and nitrates commingled in close vessels, in connexion with the ordinary sulphuric acid chamber, and for the purpose as set forth.

260. PROCESS FOR THE PRODUCTION OF SULPHATE AND OXIDES OF COPPER; Homer Holland, Westfield, Mass.

Claim—The production of sulphate of copper, together with the oxides of copper, from its various sulphurets, by the use of the nitrate of soda, according to the process already described.

261. MODE OF TREATING METALLIFEROUS SULPHURETS; Homer Holland, Westfield, Massachusetts.

Claim—The treatment of metalliferous sulphides with the native nitrate of lime, or nitrate of lime and magnesia, in iron vessels, in the manner set forth.

262. BEE-HIVES; Jesse Jacobs, Yellow Springs, Ohio.

Claim—The "valve," composed essentially of the vestibule, an adjustable counter-weighted valve pedal, arranged in the manner specified.

263. STRAW-CUTTERS; Aaron E. James, Decatur, Illinois.

Claim—Feeding the straw towards the knife, by means of two feed rolls between which the straw passes, when said rolls or cylinders are both operated simultaneously by the positive action of separate pawls, or their equivalents, working in ratchets made and arranged in said rolls, in the manner described.

264. WATCHES; Henry Boehm James, Trenton, New Jersey.

Claim—Controlling the active length of the pendulous or hair spring of a watch, or other time-keeper governed by a balance, by means of combined laminæ of different metals, so applied to act upon the end of the spring which has been commonly fixed that, by an increase or diminution of temperature, the said spring is caused to be taken up or let out through the curb pins, or their equivalents, and so to compensate for the expansion and contraction of the said spring and the balance, as described.

265. PREPARATION OF TOBACCO; George Jaques, Somerville, Massachusetts.

Claim—The described preparation of tobacco, consisting of the soluble and volatile portions, as set forth.

266. APPARATUS FOR HEATING WATER; James M. Jay and John Darmer, Canton, Ohio.

Claim—The combination and relative arrangement of the parts composing the water-heater, as set forth.

267. COTTON SEED PLANTERS; Charles Kesler and Fred. Reinhard, Columbus, Texas.

Claim—The arrangement in a hopper of the roller, with stirring teeth and feeding teeth, in combination with the perforated partition and the distributing roller, as specified.

268. COTTON CULTIVATORS; John R. King, Raleigh, Tennessee.

Claim—The arrangement of the frame and wing or mould-board, cast solid together, extra landside with its tenons and brace, with the cotton scraper, as described.

269. FOLDING BEDSTEAD; John B. Koch, City of New York.

Claim—The combined arrangement of the shoulder and eccentric, both situated below the rails and inside the bedstead, to secure the side rails in their proper place when the bedstead is unfolded, and at the same time to relieve the pins of the strain, in the manner specified.

270. HORSE HAY RAKES; Samuel Lessig, Reading, Pennsylvania.

Claim—The swingletree, sliding bar, 3, spring, braces, 6, axle, bar, g, sleeves, beam, braces, j, slotted teeth guides, rollers, arms, and connecting bars, 11, constructed and arranged as set forth.

271. ROOFING COMPOSITION; S. M. Logan, Richmond, Indiana.

Claim—The described composition, constructed and used substantially as specified.

272. EXCAVATING MACHINE; Thomas R. Markillie, Winchester, Illinois.

Claim—1st, The combination of the carrying wheel, as constructed and operated, with the reversible plough, so arranged for the purposes set forth. 2d, In combination with the carrying wheel and plough, I claim the elevator, as arranged and operated for the purposes described. 3d, The hinged wheel frame, arranged and combined with the lever and rock bar, for the purposes set forth.

273. Manufacture of Gunpowder; V. L. Maxwell, Wilkesbarre, Massachusetts.

Claim—The employment of alcohol in lieu of water as the vehicle to unite the particles of the ingredients of which the powder is to be composed, as described.

274. Apparatus for Forming Rubber Belting; Thomas J. Mayall, Roxbury, Massachusetts.

Claim—1st, The use of the two rollers, u and v, acting together so as to form the bolt into a gutter shape, whereby the first step in the process of folding the outside sheet or covering of rubber or gutta percha over the body or inner fabric of the belt is effected. 2d, The roller, x, having two tapering surfaces and a central disc, whereby the overlapping of the covering or outer sheet over the inner fabric is completed, and the edges of the outer sheet or covering brought to a true and even line before being united. 3d, Bringing the two edges of the outer sheet or covering evenly together, so as to form a true and perfect joint, and complete the formation of the belt or band by the employment of two or more rollers, arranged in relation to each other, so that the said belt or band shall be drawn partially around the periphery of either or all the said rollers, in the manner set forth. 4th, In combination with the machinery for forming the belt or band, I claim the device for cutting both the outer and inner sheets into straps of any desired width, as described.

275. Cotton Gins; William McLendon, Greenville, Georgia.

Claim—Beveling the edges of the roll box from the saws, as set forth.

276. Seed Planters; James T. Mercer, Seneca Township, Ohio.

Claim—The arrangement of the handles, beam, pivot, stirrup, wheel, arms, lever, slide, hopper, spring, markers, and coverers, constructed as described.

277. Cotton Cultivators; Peter Monaghan, Camak, Georgia.

Claim—In combination with the hinged frame of a cotton cultivator, the spring, which is secured to the tongue of said cultivator, for the purpose of automatically raising the rear end of the machine, when the same is released by the operator, in the manner described.

278. Rolling Corrugated Metals; Richard Montgomery, City of New York.

Claim—The combination and relative arrangement of the corrugating rolls with the holding and smoothing rolls, forming roll, H, and carriage, operating in relation to each other as set forth.

279. Railroad Car Coupling; Conrad Norpel, Newark, Ohio.

Claim—The arrangement, 1st, of the jaw, A, with the beam, B, and pin, D, for the purpose aforesaid. 2d, Of the jaw, K, with the pin, L, combined with the coupling bar and fish-tailed end, for the purpose described. 3d, Of the two wings combined with the slide, for the purpose described.

280. Mode of Operating Saw-mill Blocks; A. B. Norris, St. Louis, Missouri.

Claim—The use of a lever with a vibrating fulcrum, in combination with the dog or reciprocating carriage, as the means of communicating motion to the slides or knees of saw-mill head blocks, as described. Also, the combination of the cam lever with the knee, and the means of operating the same for the purpose of securing the said knee, as described.

281. Seeding Machines; Worden P. Penn, Belleville, Illinois.

Claim—Arranging the grass seed hopper in front of the grain hopper, with the reflector fixed against its under side, in relation to the grass seed-box and the grain box, and the pipe and leader, as described.

282. Seed Drills; Worden P. Penn, Belleville, Illinois.

Claim—The arrangement of the endless chain with the eccentric bar and valve bar, with the valves thereto attached, for the purpose of closing and opening the said valves and raising the flukes simultaneously in the manner described.

283. Auger; Napoleon B. Phelps, Rochester, New York.

Claim—Uniting and combining the terminating coil with the preceding one by means of the thin supporting wall, acting as a brace to sustain and strengthen the cutting portion of the bit or auger, in the manner described.

284. Manufacture of Porous Ware; Bradford S. Pierce, New Bedford, and Mason R. Pierce, Mansfield, Mass.

Claim—The manufacture of porous drain pipes, and other vessels which require to possess the property of porosity, when formed from the ingredients set forth, and made to cohere by the process of tampering, or other equivalent mode of pressure, as described, and receiving its porosity from the small proportion of water used in mixing the ingredients, as described.

285. Seeding Machines; James W. Prentiss, Pultney, New York.

Claim—The divided revolving cylinder and slides, arranged as set forth, in combination with the peculiarly-formed spring teeth with their cups, made and used as specified.

286. Harvesters; Samuel N. Purse, Ashley, Missouri.

Claim—The arrangement and combination of the shafts with the driving wheel and cutter and the pinions, as shown, for the purpose of changing the velocity of the knives, in the manner described.

287. Stair Carpet-fastener; Clinton Rice, City of New York.

Claim—The general combination and application of the main piece with the hook and eye, and the spring bolt and catching apparatus, as described.

288. Cultivators; Morgan L. Rogers, Spring, Pennsylvania.

Claim—The arrangement of the hooked and double curved central box, curved slotted arm, wheel, handles, sliding plates, frame pieces, and cross-piece, as described.

289. Steam Engines for Land Carriages; Robert E. Rogers, Philadelphia, Pennsylvania.

Claim—Connecting the safety valve, the gauge or try-cocks, and all the steam escape orifices of an engine and boiler, with a condensing apparatus, whereby the steam which may escape or be let off, either occasionally or continually, may be prevented from producing its peculiar harsh noise, as described.

290. Ploughs; George W. Roney, Assignor to self and Walter F. Lloyd, Bailey's Mills, Florida.

Claim—In combination with a beam, standard, handles, and shoe, rigidly connected together, the hinging of the coulter to the shoe at a, by its lower end, and the adjusting devices in the beam at its upper end, as stated and for the purpose set forth.

291. Surveying Instrument; Riley Roof, Galesburg, Illinois.

Claim—The arrangement of a revolving double spirit level adapted to a graduated circle, as set forth, for astronomical and engineering purposes.

292. Retainers for Hydraulic Purposes; Christopher E. Rymes, Charlestown, Massachusetts.

Claim—The arrangement and application of the two wedges and their operative screw shaft (provided with screws, as described,) in the follower, and with respect to, and so as to operate with, slots formed and arranged in the bars, as specified. And, in combination with the slots and the wedges, and their operative mechanism applied to the follower, as described, I claim the elevating racks and pinions, arranged in, and applied to, the follower and its upright bars, essentially in the manner as set forth.

293. Hernial Trusses; Richard S. Schevenell, Athens, Georgia.

Claim—Combining one or more spring pads and one or more thigh straps with the belt, by means of one or more clamps, screws, and nuts, applied as specified.

294. Railroad Chairs; Leander Shearer, Duncannon, Pennsylvania.

Claim—In combination with the chair formed with a lip and ears, the sliding securing block, and lugs, and cavities, in the ends of the rails, constructed and arranged as specified.

295. Electric Telegraphing Apparatus; Francis O. J. Smith, Westbrook, Maine.

Claim—The mode of combination of apparatus, instruments, and machines, used conjointly in the manner and for the purposes described, and dispensing therein with all artificial insulations of conducting circuits for telegraphic purposes.

296. Brakes for Horse Cars; John Stephenson, City of New York.

Claim—Arranging the brakes of a reversible car or other vehicle, as described, so that the same can be applied from the driver's seat with equal facility, in whatever direction the car or vehicle may be turned.

297. Lathe Attachment for Cutting Veneers; B. F. Sturtevant, Boston, Massachusetts.

Claim—Compressing the wood in the immediate vicinity of the edge of the knife, by means of the presser bar, or its equivalent, arranged as set forth. Also, the cutters, or their equivalents, for the purpose specified.

298. Apparatuses for Relieving Spinal Curvature; Charles F. Taylor, City of New York.

Claim—1st, A spinal supporter or assistant, in which two longitudinal dorsal plates or supports are jointed together in sections, in the manner described. 2d, Arranging the dorsal plates in the manner described, by which the pressure which is exerted in a forward direction is thrown upon the angles of the ribs, instead of upon the vertel braces or vertebral columns, as formerly.

299. Brush for Finger Nails; William Thompson, Buffalo, New York.

Claim—The combination of a stationary or movable cylinder with a circular brush, as described.

300. Seed Cultivators; Samuel D. Tracy, Vernon, New York.

Claim—Giving the zigzag or alternate opposite inclinations to the blades of the spur wheels, in the manner set forth. Also, the combination of the movable or adjustable cutters and their slotted supports with the zigzag spur wheels, in the manner specified. Also, the arrangement of the seed box in grooves in the underside of the hinged seat, so as to be adjustable beneath it, removable therefrom, or turned up therewith, as described. Also, the vibrating seed-distributor, constructed as specified.

301. Stoves; John G. Treadwell, Albany, New York.

Claim—Arranging the dampers, a and c, with the ventilating flue, and with the draft flue, in such a manner that the ventilating flue may be opened or closed while the draft flue is either open or closed, or vice-versa, the damper, a, being made to subserve a double purpose.

302. Machines for Preparing Plug Chewing Tobacco; Walter J. Van Horn and Wm. Alexander, Louisiana, Missouri.

Claim—A machine for preparing and cutting tobacco, consisting of a central cylinder, endless belts, belt rollers, pressing rollers, receiving table, and cutting rollers, arranged and operating as described, so that the leaf tobacco, on being fed from the table, will be pressed, cut, and delivered in the form of plugs, as set forth.

303. Ploughs; Samuel Walker, Kingston, Georgia.

Claim—The arrangement of the beam, bars, foot, and handles, as described, in order to permit of the adjustment of the parts, as set forth.

304. Railroad Chairs; J. W. Wetmore, Erie, Pennsylvania.

Claim—The use of a yoke band passing through notches in the hands and webs of the "T" or "H" rails at the joint, and keyed by a wedge under the plate, arranged as described.

305. Cotton Presses; Paul Williams, Lodi, Mississippi.

Claim—The combination of the levers, H H and J J, with the levers, I I and K K, links, and projections, arranged as set forth.

306. Spindles and Flyers; Cyriel E. Brown, Assignor to self, John Tenny, and John Rhodes, Millbury, Mass.

Claim—The arrangement of the secondary or tubular stationary bearing with the flyer and spindle, as described. Also, the combination of a helical eye with the flyer arm and its hook, and to open in the hook. Also, making the top of the bearing and that of the flyer neck with an oil channel, so arranged as not only to receive or catch the oil that runs off the spindle, but direct or conduct it between the rubbing surfaces of the said neck and bearing. I do not claim an oil cap as ordinarily applied to the foot of a spindle, nor as applied to a cop tube and spindle, as shown in the United States Patent, No. 16,298; but I claim combining or arranging an oil receiver and bearing with the secondary bearing tube, and so as to surround it, the spindle and flyer neck, in the manner specified.

307. Straw-cutters; Franklin B. Hunt, Assignor to R. D. Van Deursen and J. B. Gibbs, Cincinnati, Ohio.

Claim—The described feeding device, consisting essentially of the rolls, link bearings, rest blocks, and springs, arranged with reference to each other, and so as to operate conjointly as set forth.

308. Sewing Machines; James Rowe, Assignor to self and Martin B. Ewing, Cincinnati, Ohio.

Claim—The bar or bracket, h, on the lower end of the needle bar, so that it shall, in combination with the looper bar, k k′, and the feeding levers, by positive movement, when it is driven by the crank pin, all operating in the manner set forth.

309. Portable Register; Charles H. Watson, Assignor to self, A. L. Ashmead, and E. W. Carr, Philadelphia, Pennsylvania.

Claim—1st, A portable alarm register, constructed and operating as described. 2d, The dogs on the annular plates, in combination with the pins on the inner front plate, as described. 3d, The combination of the

dogs with the notches or pins of the annular plates, and the openings in the rims through which the dogs operate, as described.

310. PEACH-PARER; Mary E. Hemans, Administratrix of the estate of Alva Hemans, deceased, Henderson, Texas.

Claim—The combination of the rotating and elastic or yielding tines or prongs, knife stock, and plate or bed, arranged as set forth.

311. REVOLVING FIRE ARMS; Joseph Gruler and Augustus Rebety, Norwich, Connecticut, Assignor to the Manhattan Fire Arms Company.

Claim—The use of the intermediate recesses, in combination with the stop, actuated by the hammer in pistols where the cylinder is revolved in the act of cocking the pistol, as described, thereby effecting a self-acting lock of the cylinder, midway or otherwise between any two cones.

EXTENSIONS.

1. CORN SHELLERS; Thomas D. Burrall, Geneva, New York; patented December 6, 1845; extended December 6, 1859.

Claim—Making the concave plate or disc with a concave face and circular opening provided with a lower and upper lip for the discharge of the cobs, in combination with the sheller and with the sheller bottom, and also with the door or valve in the side for broken cobs, &c., and also the cylindrical hopper and spring, in combination with the feeder, as described.

2. DREDGING MACHINES; James Hamilton, City of New York; patented March 30, 1852; ante-dated Dec. 16, 1845; extended December 6, 1859.

Claim—The shovels or scoops forming the bottom of the compartment in a proper frame, and moving at one end on a hinge or similar contrivance, the other end being lowered to cause the scoop, as the frame is moved along, to collect the sand or mud or other material operated on, and retain the same by suitable mechanical means operating to lift the scoop and close the bottom, as described.

3. COOKING STOVES; Samuel Pierce, Troy, New York; patented Dec. 6, 1845; re-issued April 24, 1847; re-re-issued July 31, 1847; extended December 13, 1859.

Claim—Making the top of the metal ovens of cooking stoves of fine brick, or other earthy substance, when this is combined with a stove in which the products of combustion from the fire chamber pass first over the top of the oven, as described, whereby the heat in the oven is equalized, and the vapors or gases evolved in the oven are absorbed and carried off, as described. Also, the arrangement of parts by which I supply the fire with heated air, said arrangement consisting mainly of the apertures in the front plate or doors and the plate, a, in front of which the air must descend on its passage to the grate bars: the heating of the admitted air has been attempted under other arrangements, and I limit myself in this particular, therefore, to the special combination of parts by which I attain this end. And finally, making the plate of that part of the oven which extends under the grate, in the manner as described, and connected with a receptacle for ashes at the bottom for the purpose of discharging the ashes that fall from the grate, whereby I am enabled to heat this part of the oven more effectually and equally, and to avoid the burning out of the grates.

4. MACHINERY FOR DRESSING COMBS; Calvin B. Rogers, Saybrook, Connecticut; patented Dec. 20, 1845; extended December 20, 1859.

Claim—The manner in which I have arranged the apparatus for carrying the plates between the cylinders, consisting of the box, the slide with its piece, and the wheel connected by the rod to the slide and to the shaft by the small wheel, and the gripe, heretofore described, operating as before stated. Also, the manner in which I have arranged the top bed, whereby plates varying in thickness are equally scraped, not reducing the thickness of one more than another, said arrangement consisting of the spring, and the position of said bed with its space. Also, the manner in which I have arranged the chisels for scraping, smoothing, and shaping the plate, said arrangement consisting of the levers, the cross-pieces, and the apparatus for securing the chisels to the cross-pieces, and for securing the cross-pieces to the levers, and for the movement up or down for the same by the screws. Also, the manner in which I have arranged the box to receive the plates from the top bed, consisting of the spring on the underside of the lid, and the bed with its tapering rod clasped by the springs under the said box, operating as before stated. And I hereby declare that I do not intend by these claims to limit myself to the exact form or arrangement of the respective parts and combinations, as described and represented, but to vary these as I may deem expedient, while such arrangement and combinations are substantially the same with those made known.

5. STEAM BOILERS; James Montgomery, City of New York; patented December 26, 1845; extended December 27, 1859.

Claim—The employment of vertical, or nearly vertical, water tubes for steam boilers or generators that open into water chambers at top and bottom, which water chambers are connected together by a surrounding jacket or water space made singly or in sections, to admit of the free circulation of the water which, rising in the tubes by the effect of the heat, will descend in the surrounding jacket or external water space or spaces, and thus by this circulation carry off the heat from the tubes and prevent them from overheating, when this is combined with the fire chamber placed at the side of the boiler and outside of the series of tubes, whereby the tubes are prevented from being overheated and unequally expanded to an injurious extent, and the water kept cooler in the jacket than in the series of tubes. Also, in combination with vertical, or nearly vertical, tubes and surrounding water space or spaces, the employment of a fire chamber outside of the series of tubes, and so arranged and located as to apply the most intense heat at their upper ends and the reduced heat towards their lower ends, whereby a greater circulation and evaporation are obtained, with a given amount of fuel, than by any plan known to me, thereby not only economizing fuel, but effectually preventing the incrustation of the tubes by the deposit of mineral and other solid matters. Also, the employment of a diaphragm or partition in the flue space between the series of tubes surrounded by the water space or spaces, and in combination therewith to divide the same into two parts, that the products of combustion after passing around the upper end of the tubes may pass around their lower ends, and thus more effectually expose the upper end of the tubes to a more intense heat than their lower. Also, the making of the bottom of the boiler of a conical or dished form, with a mud or blow-off valve in the lowest part of the concavity, in combination with the vertical tubes communicating with the bottom, in the manner described, to permit the deposit of the sediment—there being a water space surrounding them to induce circulation of the water up the tubes towards the mud or blow-off valve.

ADDITIONAL IMPROVEMENTS.

1. CLOTHES PINS; Ephraim Parker, Marlow, New Hampshire; patented January 15, 1856; additional dated December 13, 1859.

Claim—Adding bits to the machine so as to bore the stuff at the time it is being shaped and turned at the same operation. Also, as above, the boring the stuff first and then putting it upon a small mandrel which revolves, so that the work shall be turned and shaped to the right pattern, and finished at each end upon its own centre hole, all at one operation. Also, the above improvements, as before set forth, or any equivalent, which substantially effects either of the above objects, by any other arrangements of mechanism or mechanical devices.

2. REFRIGERATORS; William Sims, Dayton, Ohio; patented February 8, 1859; additional dated Dec. 13, 1859.

Claim—The arrangement, severally, of the escape pipe, in combination with the induction pipe, so as to operate conjointly therewith and in connexion with a flue, as set forth.

RE-ISSUES.

1. COATING METALLIC SURFACES; William and William A. Butcher, Philadelphia, Pennsylvania; patented June 29, 1858; re-issued December 6, 1859.

Claim—The combined process, substantially as described, of coating metals with the composition made of india rubber or allied gum, dissolved in, and combined with linseed oil, in a heated state, in proportions substantially such as set forth, by first heating the metal to be coated to about 350°, applying the composition to the metallic surface while so heated, and then subjecting the metal so coated to about 200° of heat.

2. PLOUGHS; Isaac Rulofson, Assignor to self and Lemuel Harvey, Penn Yan, New York; patented March 1, 1859; re-issued December 13, 1859.

Claim—Moving and adjusting the beam laterally upon the standard, by means of the head and dovetailed connexions, in such a manner that the line of draft or direction of the beam shall always remain parallel with the land-side of the implement, as described.

3. BOILERS AND STEAMERS; Daniel R. Prindle, Bethany, New York; patented September 13, 1859; re-issued December 13, 1859.

Claim—The construction and arrangement of the two sections, A and B, so that the section, A, may be used separately as a caldron, or both sections be securely united and employed as an enclosed boiler for generating steam. Also, the combination of the cylindrical or cylandroidal support and fire-box entirely open at the top, with the uniting and supporting flanches of the spherical or spheroidal sections, A B, constructed so that, by presenting a thin edge only to the flanches, it allows the utmost facility of clamping and unclamping the sections, and of moving or adjusting the same, while it firmly sustains the boiler, and shields the packing between the flanches from the heat of the fires. Also, the trough, formed by the tip projecting above the upper flanch, for the purpose of containing water to protect the packing between the flanches from injury by heat.

4. PUMPS; John M. Lunquest, Griffin, Georgia; patented November 1, 1859; re-issued Dec. 13, 1859.

Claim—The arrangement of two or more cylinders, piston heads, ball valves, a a, air chamber, and valves, a′ a′, said valves being kept in position by proximity to each other and the sides of the chamber, in the manner specified.

5. HARVESTERS; M'Clintock Young, Jr., Frederick, Maryland; patented Sept. 21, 1858; re-issued July 19, 1859; re-re-issued December 13, 1859.

Claim—Giving the rake the two described regularly succeeding axial movements over and across the platform of said machine, that is to say, an elevated curvilinear movement from rear to front over said platform, and a horizontal movement from front to rear upon or near to said platform, by the means described.

6. PANS FOR EVAPORATING CANE JUICE; D. M. Cook, Mansfield, Ohio; patented June 22, 1858; re-issued December 20, 1859.

Claim—1st, The combination with a fire furnace of a sugar evaporating pan, when said pan is constructed and arranged so as to allow of a continuous circulation of the syrup in an indirect course over its surface, during the process of boiling. 2d, So arranging the pan on the surface, that a portion of its bottom surface near each side shall not be exposed to the direct heat of the furnace, and thus while the intermediate surface of the bottom of the pan is intensely heated, the other portions remain comparatively cool. 3d, Retarding the escape of the syrup, or facilitating its escape, either by giving the pan a vibrating motion, or a greater or less inclination. 4th, An evaporating apparatus which allows of a circulation of the steam of syrup, boils it at the centre of the pan and cools it at the sides of the same, and affords facilities for regulating the flow of the steam, as set forth.

7. STOP-COCKS; Erastus Stebbins, Chicopee, Massachusetts; patented April 19, 1859; re-issued December 20, 1859.

Claim—1st, The arrangement and combination of the collar, flexible washer, and washer, as described. 2d, The chambered square nut or valve, when its seat is formed in the body of the cock, in the manner described.

8. MACHINE FOR SPLITTING FIRE-WOOD; Wm. L. Williams, City of New York; patented April 19, 1859; re-issued December 20, 1859.

Claim—1st, Feeding the wood to be split by the endless chain, so arranged that the chain can receive a lateral movement, for the purposes specified. 2d, In combination with the endless chain to feed the wood, as aforesaid, I claim the rollers for permitting a lateral movement and taking up any slack. 3d, The yielding pawls, in combination with the feeding chains, for permitting backward movement to the wood as the knife enters the same, thereby preventing the wedging of the wood or injury to the parts. 4th, The spurs, to give lateral motion to the chain, in combination with the arms and yielding connexion to the rods, as described. 5th, The yielding end pieces to regulate the delivery and sustain the wood while being split, and prevent the same falling over before being separated by the second cut.

9. SKELETON SKIRTS; James Draper, Hudson City, New Jersey, Assignor to self and S. H. Doughty, Assignors to selves, James Brown, and William King, City of New York; patented October 4, 1859; re-issued December 27, 1859.

Claim—The manufacture of skeleton skirts, in which the hoops are fastened between separately woven

parts of the tapes, as described, when the parts are woven together as single tapes between the hoops, and separately as distinct tapes at the points where the hoops are received.

10. TABLE CASTER; R. Gleason & Sons, Assignees of R. Gleason, Jr., Dorchester, Mass.; patented March 8, 1859; re-issued December 27, 1859.

Claim—1st, The combination of the caster and egg-stand. 2d, The combination of the caster and bell. 3d, The combination of the caster, egg-stand, and table bell, as described.

11. EVAPORATING APPARATUS; James McCracken, Bloomfield, New Jersey; patented March 13, 1855; re-issued December 27, 1859.

Claim—A pan for containing solutions to be heated, in combination with a vessel contained therein, the top and bottom of which are connected by a series of vertical, or nearly vertical tubes, the interior of such vessels being connected with proper pipes for the supply of steam and the escape of steam or condensed vapor, constructed in the manner set forth.

12. COOKING STOVES; Giles F. Filley, St. Louis, Missouri; patented June 14, 1853; re-issued Dec. 27, 1859.

Claim—1st, The flaring enlargement of the side flues, C C and D D, from the space above the oven to the flue space, E, which extends under the entire front end of the oven—and also the flaring enlargement of the central flues of F and of G, from the flue space, E, to the upper end, G, for the purpose of increasing the draft of the stove, as set forth. 2d, Separating the front of the oven from the front plate of the stove, and also from the hearth plate, and from the back plate of the fire chamber, by means of the flue space, H, which communicates freely with the flue space, E, and is closed at all other points—the said arrangement enabling the flue space, H, to arrest the great amount of heat that will be radiated from the back plate of the fire chamber, and conduct the same (by means of the circulation which it will create in said flue space,) into the flue space, E, for the purpose of producing the beneficial results herein particularly set forth.

DESIGNS.

1. TRADE-MARK; O. T. Bragg and M. Burrows, St. Louis, Missouri; dated December 20, 1859.
2. TRADE-MARK FOR SOAP-BOXES; Thomas and Samuel Lincoln, Providence, Rhode Island; dated December 20, 1859.
3. FLOOR OILCLOTHS, CARPETS, &c.; Jeremiah Meyer, City of New York, Assignor to Alden Sampson, Manchester, Maine; dated December 20, 1859.
4. CARPETS, &c. (2 cases); E. J. Ney, Assignor to the Lowell Manufacturing Company, Lowell, Massachusetts; dated December 20, 1859.
5. PARLOR STOVES; Garrettson Smith and Henry Brown, Assignors to J. G. Abbott, Philadelphia, Penna.; dated December 20, 1859.
6. CARPET PATTERNS (5 cases); H. G. Thompson, City of New York, Assignor to the Hartford Carpet Company, Hartford, Connecticut; dated December 20, 1859.

MECHANICS, PHYSICS, AND CHEMISTRY.

*Purification of Paraffine or Solid Portable Illuminating Gas.**

Since the discovery, by Reichenbach, of the existence of the curious hydro-carbon "paraffine" in tar, much chemical attention has been directed towards the effective utilization of its peculiarly valuable properties. Up to the present time little has been done with it, and the crude material, as produced in the distillatory processes for the product of oils and fats, accumulates in many cases as a useless incumbrance in the works of manufacturing chemists. Originally detected in the tar of beech wood, it is now made in large quantities from peat, and more recently still, from that wonderful debateable mineral, "boghead coal," peculiar to a certain district of Scotland. It is a white, crystalline, solid, volatile substance, bearing a strong resemblance to wax, but is quite tasteless, colorless, and inodorous, is fusible at about 110°, and resists the action of the powerful caustic acids, whilst alkalies and chlorine fail to exert the smallest action on it. Its peculiar name is derived from the words *parum* little, and *affinis* akin, to denote its remarkable chemical indifference or want of affinity.

The great difficulty in the way of bringing paraffine within the working commercial pale, has been that of purification, and decoloration.

*From the Lond. Practical Mechanics' Magazine, Sept., 1859.

Now, however, we are coming to important practical results in this way, and we have before us some beautiful samples of hard, brilliant, white, and sweet paraffine. It resembles spermaceti in its silky feeling and physical structure, but at the same time presents a waxy appearance, gives a powerful clear flame without soot, melts into a colorless oil, and it may be properly considered as a solid portable illuminating gas. It holds a successful competition with wax and sperm, on account of the great uniformity of its combustion, high illuminating power, and beautiful appearance, melting at a temperature of 29° above that previously made. This is the patented product of a process lately invented by Dr. C. M. Kernot, of Gloucester House, West Cowes, Isle of Wight. In his process Dr. Kernot boils the crude paraffine in water or steam, so as to free it as much as possible from its oil, and render it inodorous and hard. He discards acids altogether, and taking advantage of the fact, that the tar with which the crude paraffine is mixed, melts at a higher temperature than the paraffine itself, he heats the raw material to the temperature just sufficient to disengage the two constituents, and he then filters it, when the pure paraffine passes through the filtering medium, and the tar, with any other impurities, is left on the filter.

The melting is performed in a pan heated with steam tubes, and fitted with a movable perforated bottom, on which is placed a layer of felt as a filter. As paraffine melts at about 110° or 112°, the heat is raised to 130°, taking care not to reach 180°, the melting heat of tar.

When it is necessary to decolorize any oil which may be left in the paraffine, and cannot be taken out by hydrostatic pressure, or by centrifugal apparatus, the inventor uses chloro-chromic acid, or chloro-chromic acid gas, agitating the acid and paraffine together, in a "compound opposite rotator," at a temperature of from 110° to 200°. After this, the mass is washed with warm water to get rid of the coloring matter and acid, and it is then re-melted, adding from ten to twenty per cent. of any light, easily evaporating fluid, such as fusel oil, benzole, photogen, or alcohol. The paraffine is finally cast in moulds for treatment in the hydrostatic press.

The product is really very fine, and as the process is so simple, it is probable that it will come into general use. It has the same per centage and composition as olefiant gas, hence its great utility in the manufacture of candles; and it burns superior to spermaceti or wax, and mixed with either, or with the solid fat acids, it is destined to become an important branch of industry. The firm, in whose hands the manufacture of the new article now is, are making from three to six tons of it per week.

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*Vegetable Leathers.**

The *Mechanics' Magazine* gives the following account of what is being done in this direction :—

"Having seen some specimens of these leathers, as well as various articles of utility manufactured therewith, we have been induced to pay the extensive works of Messrs. Spill and Co., the eminent Gov-

* From the Journal of the Society of Arts, No. 345.

ernment contractors on Stepney-green, a visit, in order to cull sufficient to place upon record the present position of artificial as a substitute for real leather. The face and general character of the vegetable leather resembles the natural product so closely that it is only by actual examination that the difference can be determined. This is more particularly the case in that description which is made for book-binding, the covering of library tables, and like purposes. Amongst other advantages it possesses over leather proper, may be mentioned, that, however thin the imitation is, it will not tear without considerable force is exercised, that it resists all damp, and that moisture may be left upon it for any period without injury, consequently, it does not sodden or cockle, is always dry, and its polish is rather increased than diminished by friction. Add to these facts that any attempt to scratch or raise its surface with the nail, or by contact with any ordinary substance, will not abrade it, and enough will have been said to justify its entering the list against an article of daily use, which has of late years been deemed far from sufficient for the demand, and has consequently risen in price to the manifest loss and injury of every class of the community. We believe that the largest entire piece of real leather that can be cut from a bullock's hide is not more than seven feet by five, and this includes the stomach and other inferior parts. Vegetable leather, on the contrary, is now produced 50 yards in length and 1¼ yards wide, every portion being of equal and of any required thickness, and the smallest portion is convertible. We were agreeably disappointed, however, to find that, instead of vegetable leather being a discovery requiring the aid of ourselves and contemporaries, it was, although so young, an active agent in the fabrication of numerous articles in daily requirement, and that it had already become the subject of large—indeed, we may say enormous—contracts. Caoutchouc and naphtha are used in its manufacture, but, by a process known to the senior of the firm, who is himself an accomplished chemist, all odor is removed from the naphtha, and the smell of the vegetable leather is rendered thereby less in strength, if anything, than that of leather. The principal objects to which it is at present applied, although it is obvious it will take a wider range of usefulness than leather itself, are carriage and horse aprons, antigropole, soldiers' belts, buckets which pack flat, harness of every description, book-binding, &c. For the latter, its toughness, washable quality, and resistance to stains render it remarkably fitted. Its thickness, which may be carried to any extent, is obtained by additional backings of linen, &c., cemented with caoutchouc, and its strength is somewhat marvellous, while in the all-important commercial view, it is but one-third the price of leather. Many of the articles we were shown possessed the appearance of much elegance and finish; but it was curious to observe that although most of these could be made without a stitch, and within the factory itself, a deference to the feelings of the workmen in the several trades has been shown by the firm, and the material is given out as ordinary leather to undergo the process of the needle, which it submits to with a greater facility than its original prototype. Perhaps this concession upon the part of the discoverers is both wise

and politic, inasmuch as their object is more to manufacture and supply the article in the gross to the saddler, &c., than to make it up on their own premises—a monopoly which might become exceedingly formidable and injurious. We think we have glanced, although hastily, at the principal features of this important discovery, and said quite sufficient to raise the curiosity of all interested in the advance and consequent cheapening of our manufactures.

For the Journal of the Franklin Institute.

Particulars of the Steamer Matanzas.

Hull and machinery built by C. H. Delamater, New York. Owners, Mora Bros., Navarro & Co. Intended service, New York to Matanzas.

HULL.—

Length on deck,	205 feet.		
" at load line,	200 "		
Breadth of beam, molded,	29 "	6 inches.	
Depth of hold,	12 "	6 "	
" to spar deck,	20 "	9 "	
Frames—shape ⅂L; depth, 3½ ins.; width of web, ½-in.;, width of flanches, 3½ ins.; 14 strakes of plates from keel to gunwale, ¾, ⅝, ½-in. thick.			
Cross Floors—⅂ 18 in. deep × ½-in.			
Keel—depth, 9 ins.; dimensions, 3 ins.			
Rivets—⅞, ¾, ⅝, 3 ins. apart; double riveted.			
Draft of water, (forward and aft,)	13 "		
Tonnage, 870.			
Area of immersed section at load draft of 13 ft., 320 sq. ft.			
Rig, two masted schooner.			

ENGINES.—Vertical direct.

Diameter of cylinder,		56 inches.	
Length of stroke,	3 feet	9 "	
Maximum pressure of steam, 22 lbs.			
Cut-off—one-third.			

BOILER.—One—Tubular.

Length of boiler,	24 feet.		
Breadth "	16 "		
Height " exclusive of steam chimney,	11 "	1 inch.	
Number of furnaces, 3.			
Breadth "	5 "	2 inches.	
Length of grate bars,	7 "	6 "	
Number of tubes, above, 860—flues below, 3 arches.			
Internal diameter of tubes, above,		3 "	
Length of tubes, above,	3 "	4 "	
Diameter of smoke pipe,	5 "	2 "	
Height " above grates,	42 "		

PROPELLER.—

Diameter of screw,	14 feet.		
Length "	3 "	6 inches.	
Pitch "	22 "		
Number of blades, 4.			

Remarks.—One independent steam, fire, and bilge pump. Four bulkheads. Date of trial, March, 1860. C. H. H.

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Aerometry. Translated from the Hydraulics of D'Aubuisson de Voisins. By J. Bennett.

(Continued from page 132.)

SECOND SECTION.

In this section we shall treat of the *Motion of Air* in conduit pipes. Combining the results obtained, with the principles laid down in the preceding Section, we shall calculate the effects of *Blowing Machines.*

CHAPTER FIRST.

Motion of Air in Pipes.

516. *Resistance of Pipes. Its expression.*—If to a reservoir which is always filled with equally compressed air, we fit a long pipe whose extremity is either entirely open, or provided with an ajutage contracting the orifice, the air will enter it, will pass through, and will issue, producing a continuous blast.

If we designate by H the height of the manometer at the reservoir, it will represent the force (effort) which drives the air in the tube. If the latter opposes no resistance to its motion, it will still indicate the force which presses the issuing air; then, a second manometer, placed upon a second reservoir, containing the outlet pipe, would also be held at the height H. But this is not the case; the resistance of the pipe destroys a portion of the initial force; and the second manometer will only have a height h, a height smaller than H, and which alone produces the velocity of issue. Thus the resistance will absorb a part of the first force equal to $\text{H}-h$; and this quantity will thus represent the resistance.

517. As with tubes conducting water, the resistance will be an effect of the action of the sides, and it will be accordingly increased with their length, and with their circumference or diameter (184). It will also be in the inverse ratio of their section, or as the squares of the diameter; and will increase proportionally to the square of the velocity. As to the term expressing the relation between the resistance and the velocity, taken in the first power (107) it may be wholly neglected; according to Hutton's observations, its effect is insensible for velocities of air from 10 to 328 feet.* Now, in pipes, the velocity does not exceed 164 feet, and is seldom ever below 10 feet.

Consequently, if u is the mean velocity in a pipe, with a length L, and diameter D, n^1 being a constant co-efficient, we shall have

$$\text{H}-h=n^1\frac{\text{L D}\,u^2}{\text{D}^2}=n^1\frac{\text{L}\,u^2}{\text{D}}.$$

518. *Equation of Motion.*—The motion of air in a pipe differs in this respect from that of water, in that its velocity is not entirely uniform, but gradually increases from the commencement to the end, in the inverse ratio of the respective pressures from $b+h$ to $b+\text{H}$, b being the height of the barometer.

* New Experiments upon Artillery, second part, translation of M. Terquem, pp. 112 and 148.

In fact, if when the permanence of motion is well established, we imagine in the pipe, two extremely thin cross sections of equal thickness, and at some distance apart, there must pass through each of them the same mass of air, and the same number of molecules in the same time. In the lower section, where the pressure, and therefore the density of the air is less, there will be at any instant, fewer molecules than in the upper; they must pass then more rapidly, and so much the more as the density is less.

The diminution of density, as well as that of pressure, being proportional to the length of pipe, will be in an arithmetrical progression; the same will be the case for the increase of the velocity. Consequently, the mean u will be at the middle of the pipe. The pressure there is $\frac{1}{2}(b+\text{H}+b+h)=b+h_1$, making $\frac{1}{2}(\text{H}+h)=h_1$ at the extremity, it is $b+h$; thus, if we designate by v, the velocity at the end, we shall have

$$u : v :: b+h : b+h_1 \text{ or } u=v\frac{b+h}{b+h_1}.$$

519. If the conduit is terminated by an ajutage, whose diameter of orifice is d, and with a velocity V of issuing fluid; the velocities being in the inverse ratio of the sections, or the squares of the diameter, we shall have $v=\text{V}\frac{d^2}{\text{D}^2}$, or more exactly $v=\frac{m\,d^2}{\text{D}^2}$, m being the co-efficient of contraction at the orifice; it will generally be ·93 in the ajutages of pipes (509). Moreover, and other things being equal, V^2 is proportional to h, or equal to $n''\,h$, n'' being another constant multiplier. Thus,

$$u^2=n''\,h\frac{m^2\,d^4}{\text{D}^4}\left(\frac{b+h}{b+h_1}\right)^2;$$

this value should be substituted in the above equation.

In the second member, we shall have three constant multipliers n', n'', and m; we will represent their product by n; it may also comprise the factor $\left(\frac{b+h}{b+h}\right)^2$, variable it is true, but within very narrow limits, and the experiments giving n, will implicitly give its value for analogous cases. Consequently making $n'\,n''\,m\left(\frac{b+h}{b+h}\right)^2=n$, we have

$$\text{H}-h=n\frac{h\,\text{L}\,d^4}{\text{D}^5}.$$

520. The second member expresses only the resistance of the sides; but there is another besides this, arising from the choking of the fluid vein in its passage from the reservoir into the conduit: it operates with the first in reducing the height of the manometer from H to h, and consequently in producing H—h; its expression, which is (204)

$$h\frac{m^2\,d^4}{\text{D}^4}\left(\frac{1}{m'^2}-1\right),$$

m' being the co-efficient at inlet of the conduit, should then be introduced in the second member. But, from what has been said in Nos. 55 and 204, the effect of this contrac-

tion will be extremely small, and may be neglected in large conduits; moreover, it may be implicitly comprised in the value of n derived from experiment.

521. The height h is that of a manometer to be placed upon a reservoir at the extremity of the conduit, and is the same as that of the outlet ajutage at which the outlet ajutage is held. But, in reality, we have no such reservoir; and the extreme manometer is established directly upon the conduit itself, quite near the ajutage. The height h' to which it rises is less than h, the height really due to the velocity of issue, by a quantity equal to the height due the velocity v which the fluid has under the manometer (208 and 213) a height which is $\frac{v^2}{2g}$, or, in a column of mercury,

$$\frac{v^2}{2g}\cdot\frac{d}{\text{D}}=\frac{\text{V}^2}{2g}\cdot\frac{m^2 d^4}{\text{D}^4}\cdot\frac{d}{\text{D}}=h\frac{m^2 d^4}{\text{D}^4},$$

remembering that

$$\text{V}=\sqrt{2g\,h\,\frac{\text{D}}{d}}(500.)$$

Thus,

$$h'=h-h\frac{m^2 d^4}{\text{D}^4}=h\left(1-\frac{m^2 d^4}{\text{D}^4}\right),$$

and consequently,

$$h=\frac{h'}{1-\frac{m^2 d^4}{\text{D}^4}};$$

and the equation of motion with h' will be

$$\text{H}\left(1-\frac{m^2 d^4}{\text{D}^4}\right)-h'=n\,\frac{h'\,\text{L}\,d^4}{\text{D}^5}.$$

But experiments to be shown hereafter, in which the term $\frac{m^2 d^4}{\text{D}}$ reaches as high as ·453, prove that the formula is better established, that is to say, that n is more constant in neglecting than in preserving this term, and consequently in taking the height really given by the manometer for h; or in other words, for the generating height of the velocity of issue.

522. *Determination of the Constant Co-efficient.*—We now come to the determination of n in the equation

$$\text{H}-h=n\,\frac{h\,\text{L}\,d^4}{\text{D}^5},$$

H and h being the heights of the manometers placed upon the conduit, the one at the origin, the other at its end immediately in front of the nozzle.

To arrive at this properly, as well as to establish the laws of resistance, I made a great number of experiments, the details of which may be found in Tomes III and IV of the *Annales des Mines*, (1828 and 1829.) I merely refer to them and confine myself to the following observations:

I had to establish at the mines of Rancié (department of Ariége,) a ventilator, which was to carry a distance of 1312 feet the air which it received from a "*trompe*," a kind of blower used at the iron works of the Pyrénées, the Alps, &c. This air was to be conducted through a tin pipe ·328 feet in diameter.

It was laid in pieces 65 6 feet in length. As soon as one of them was laid, there was fitted in succession at its end, nozzles or slightly conical ajutages, whose diameter at the orifice was ·16 ft., ·13 ft., ·098 ft., and ·065 ft., and which nearly always made with the pipe an angle of 135°. During the experiments, three different quantities of water

were let into the "*trompe*," to insure different velocities. A manometer, placed at the end of the conduit, quite near the base, made known the elastic force h of the air at its outlet; while another placed upon the reservoir of the "*trompe*" indicated the force H at the inlet of the pipe.

To establish the effect of the diameter of the pipes, I made two small conduits 183 ft. long; one had a diameter of ·164 ft., and the other ·077 ft.

From among over one thousand experiments made conjointly by myself and M. Marot, Engineer, three hundred and twenty-five reported in the "*Annales des Mines*," served for the determination of the co-efficient

$$n\left(=\frac{(H-h)\,D^5}{h\,L\,d^4}\right):$$

I give in the following tables the results of a portion of them:

Conduit of ·328 feet diameter.						
Length of the conduit.	Nozzle of ·164 ft. diameter.			Nozzle of ·098 ft. diameter.		
	Manometer		Derived Co-efficient.	Manometer		Derived Co-efficient.
	At Origin.	At Extremity.		At Origin.	At Extremity.	
ft.	ft.	ft.		ft.	ft.	
330·05	·0633	·0249	·0247	·1093	·0889	·0285
394·03	·0725	·0249	·0248	·1049	·0830	·0272
457·68	·0741	·0249	·0226	·1125	·0889	·0235
524·78	·0590	·0177	·0233	·0932	·0725	·0220
589·58	·0593	·0164	·0233	·0784	·0607	·0200
654·54	·0741	·0193	·0227	·1066	·0784	·0223
720·19	·0735	·0219	·0193	·1108	·0784	·0233
784·62	·0830	·0206	·0202	·1138	·0814	·0206
849·62	·0902	·0206	·0208	·1197	·0837	·0206
917·70	·0932	·0193	·0218	·1213	·0800	·0228
984·24	·0918	·0177	·0223	·1197	·0784	·0217
1056·22	·1003	·0127	·0208	·1315	·0859	·0204
1129·50	·1007	·0164	·0239	·1302	·0830	·0204
1203·20	·1345	·0196	·0254	·1761	·1049	·0228
1270·10	·1404	·0193	·0258	·1315	·0784	·0216
		Mean, .	·0228		Mean, .	·0225

Pipe of ·164 ft. diameter.				Pipe of ·077 ft. diameter.			
Nozzle of ·098 ft.				Nozzle of ·065 ft.			
Length of Pipe.	Manometer		Derived Co-efficient.	Length of Pipe.	Manometer		Derived Co-efficient.
	At Origin.	At Extremity.			At Origin.	At Extremity.	
ft.	ft.	ft.		ft.	ft.	ft.	
30·66	·1214	·1102	·0244	29·19	·177	·0295	·0252
63·96	·1302	·1036	·0242	57·66	·193	·0198	·0223
99·38	·1256	·0889	·0206	82·36	·185	·0128	·0238
131·88	·1214	·0859	·0238	106·99	·200	·0113	·0227
164·16	·1154	·0705	·0248	131·88	·165	·0066	·0266
182·13	·1332	·0787	·0226	165·80	·167	·0087	·0262
Mean, . . .			·0254		Mean, .		·0247

A peculiar circumstance seems to have caused the small co-efficients upon the great conduit, especially at its middle part. The mean co-efficient, with a nozzle of ·131 feet was ·022; and ·021 with that of ·065 ft. Upon the conduit of ·164 ft. with such a nozzle it was raised to ·0248.

The aggregate of all our observations gives as a mean term, $n = {\cdot}0238$.

523. *Pressure at the Extremity of Conduit.*—We shall thus have

$$\text{H}-h = \cdot 0238\,\frac{h\,\text{L}\,d^4}{\text{D}^5}:\ \text{whence}$$

$$h = \frac{\text{H}}{1+\cdot 0238\frac{\text{L}\,d^4}{\text{D}^5}} = \frac{42\cdot 02\,\frac{\text{H}\,\text{D}^5}{d^4}}{\text{L}+42\,\frac{\text{D}^5}{d^4}}.$$

I have compared the values of h given by this formula, with those of more than three hundred observations, and the results of calculation have followed those of experiments in all their variations, high and low, whatever the given quantities of motive water, whatever the conduits and ajutages employed; when the section of the latter was ·73 of that of the former, as well as when it was but ·04. Thus, our formula, though not strictly correct in theory, has the full sanction of experiment, at least between the limits of our applications, which will be found to lie within the limits of practice.

524. *Expression of Discharge.*—Putting the above value of h in the expression of discharge (509), we have

$$\text{Q} = 6135\sqrt{\frac{\text{T}}{b+h}}\sqrt{\frac{\text{H}\,\text{D}^4}{\text{L}+42\,\frac{\text{D}^5}{d^4}}}.$$

The air is here at the pressure $b+h$, and we may reduce it to the volume it would have under the barometric pressure of 2·493 ft., by multiplying by the ratio between these two pressures; taking, for $b+h$ and T, the mean values 2·559 ft., and 1·048 in No. 511, we have simply

$$\text{Q} = 4030\sqrt{\frac{\text{H}\,\text{D}^5}{\text{L}+42\,\frac{\text{D}^5}{d^4}}}.$$

525. *Discharge of Pipes entirely open.*—From the manner in which our formula of discharge has been established, it would seem to be inapplicable to conduits entirely open at their extremity, or to those whose efflux is not considerably contracted by an ajutage, and where we have $d = \text{D}$. But experiment indicates that here also their application may be made without notable error. Still, as there is no contraction at the outlet, the co-efficient m ($=\cdot 93$) placed in the numerical multiplier of the discharge, should be taken away; and the multiplier will then be 6597 instead of 6135. Let us compare now the results of the formula with those of an experiment made by M. Girard.

This engineer made use of a gasometer employed for lighting one of the hospitals of Paris, to ascertain the discharge of a pipe, whose length was gradually increased, the pressure in the gasometer being constant: it was at ·008162 feet estimated in a column of mercury. The pipe was made of gun-barrels fitted end to end, and was ·0518 ft. in diameter; at the time of the experiments the temperature was 62·0° and the barometer indicated nearly 2·486 ft. The observed discharge

was less than the calculated in the ratio of 551 to 557 or of 989 to 1000, as may be seen in the following table.

Length of Pipe.	Discharge in 1′ according to	
	Observation.	The Formula.
feet.	cubic feet.	cubic feet.
21·58	·05085	·04905
123·29	·02023	·02136
186·43	·01737	·01741
278·99	·01444	·01426
357·65	·01165	·01260
415·18	·01084	·01168
422·46	·01077	·01162
Mean,	·01946	·01967

Thus these experiments would lower the co-efficient 6597 to 6525, and we have for open pipes,

$$Q = 6525 \sqrt{\frac{T}{b+h}} \sqrt{\frac{H\,D^5}{L+42\,D}}.$$

In such a conduit, the air issues nearly under the pressure b, and $h=o$: at the inlet the pressure is $b+H$; but H is generally small, and without error we may make $b+\frac{1}{2}H$, and even $b+H$ equal to 2·493 feet. Thus,

$$Q = 4231 \sqrt{\frac{H\,D^5}{L+42\,D}}.$$

526. *Comparison of the Discharge of Air and of Water.*—Let us compare the expression of the discharge Q in air, with that giving the discharge Q' in water, the pressure, the length, and the diameter of the pipe remaining the same.

The discharge in great velocities is (189),

$$Q' = 37{\cdot}548 \sqrt{\frac{H'\,D^5}{L+36\,D}},$$

H' being the height of the column of water, measuring the charge upon the pipe. Expressing H' in column of mercury, we have $H' = 13{\cdot}6\,H$, and consequently

$$Q' = 138{\cdot}47 \sqrt{\frac{H\,D^5}{L+36\,D}}.$$

Thus, very nearly

$$Q' : Q :: 138{\cdot}47 : 4321 :: 1 : 30{\cdot}55;$$

In other words, under the same charge, the same conduit will discharge a volume of air 30·55 times greater than the volume of water.

According to the principle laid down in No. 512, the two discharges must be in the inverse ratio of the square root of the respective densities of the two fluids, and consequently (496) as 1 to

$$\sqrt{1919{\cdot}5\,\frac{T}{b+h}}, \text{ or as 1 to } 43{\cdot}81 \sqrt{\frac{T}{b+h}},$$

or, since $b+h=2{\cdot}493$, and $T=1{\cdot}848$, as 1 is to 37·71.

527. *Discharge for any Gas.*—According to this principle, p being the specific weight of any gas compared with atmospheric air, we shall have the volume of gas discharged by a pipe, by dividing the above values of Q (525 and 526) by $\sqrt{p}$.

528. *Resistance of Bends.*—The curves of conduits when they are sharp and abrupt, considerably increase the resistance to motion: thus in my numerous experiments on bent pipes, seven angles of 45° have reduced the discharge by one quarter.

In these experiments I have seen the resistance increased, the same as for pipes conveying water, sensibly as the square of the velocity, and very nearly as the square of the sines of the angles. But to my great surprise, it did not increase proportionally to the number of angles; beyond a certain number it diminished; thus 15 angles reduced the discharge less than 7 of the same size. This phenomenon, and some other circumstances, have rendered fruitless my attempts to establish even approximately, an expression for the resistance of bends.

In practice, we avoid their bad effect by well-rounding such as we are compelled to make.

529. As to contractions which may accidentally occur, their resistance as in water pipes (200) is expressed by

$$h\, m^2 d^4 \left(\frac{k^2}{m'^2 s^2} \frac{1}{D^4}\right),$$

s being the contracted section.

530. *Examples.*—A pipe ·051805 feet in diameter, and 415·29 feet in length, is fitted to a gasometer filled with carburetted hydrogen; the height of the water manometer placed upon the gasometer is ·11099 feet; required the discharge per second.

We have $D = \cdot 051805$ feet, $L = 415\cdot 29$ feet, $H = \frac{\cdot 11099}{13\cdot 6} = \cdot 0081612$ feet, and $p = \cdot 559$, and consequently,

$$Q = \frac{4231}{\sqrt{\cdot 559}} \sqrt{\frac{\cdot 0081612\,(\cdot 051805)^5}{415\cdot 29 + 42 \times \cdot 051805}} = \cdot 015285 \text{ cubic feet.}$$

Experiment gave ·01483.

I give below, the results of four other operations made on the same conduit. In the aggregate, they do not differ but a hundredth from those of the formula.

Length of Conduit.	Discharge according to	
	Experiment.	Formula.
feet.		
123·09	·02747	·02793
186·43	·02313	·02274
268·99	·03092	·02815
357·65	·01945	·02489

531. There is a conduit 1066 feet long, and ·39 feet diameter; it is fitted to a reservoir upon which a mercury manometer stands at ·1804 feet. What diameter must be given to the nozzle to discharge 3·88 cubic feet per second?

The equation $Q = 4030 \sqrt{\frac{H\,D^5}{L + 42\frac{D^5}{d^4}}}$,

being raised to the square and transposed, becomes $d^4 = \frac{42\,Q^2 D^5}{(4030)^2\,H D^5 - L Q^2}$;

or with the numerical quantities above given

$$d^4 = \frac{42\,(3\cdot 88)^2\,(\cdot 39)^5}{4030^2\,(\cdot 1804)\,(\cdot 39)^5 - 1066\,(3\cdot 88)^2} = \cdot 0000549;$$

and extracting the fourth root, $d = \cdot 1531$ feet.

(To be Continued.)

*On the Manufacture of Malleable Iron and Steel.**

By Mr. Henry Bessemer.

[Paper read before the Institution of Civil Engineers, May 24, 1859.]

Attention was directed, in the early part of the Paper, to the ordinary mode of manufacturing iron by the puddling process; in the course of which the iron, after it "came to nature," was gathered into balls, and was then removed, as quickly as possible, to the squeezer, where much of the fluid scoria, with other mechanically mixed impurities, was driven out, leaving a mass or billet of iron composed of thousands of separate fragments of metal, the entire surface of every one of which was more or less coated with dry oxide, or fluid silicate of the oxide of iron. The great pressure exerted by the squeezer sufficed to so far remove the fluid coating of the contiguous particles, as to bring their surfaces into actual contact, and consequently to effect a union at such parts. But the whole of the matter thus displaced could not find its way between the interstices of the mass, and therefore it became locked in its numerous cavities, producing points of weakness and separation in the metal. No amount of after working or rolling could wholly displace the portions of cinder, dry oxide of iron, and of sand, which thus became mixed up with and were diffused throughout the mass, causing flaws and cracks in the iron, all more or less objectionable.

Now, if these imperfections were the natural and inevitable consequences of the conditions under which malleable iron was at present produced, it followed that defects of a similar character must also of necessity exist in steel produced by the puddling process. The granular condition of the metal, and its exposure to heat and oxygen, could not fail, in both cases, to oxidize the entire surfaces of the numerous molecules to be united into one mass; the admixture of scoria and other matters from the furnace, was equally certain to result; and also the difficulty of bringing each particle of the metal to the same degree of decarbonization and refinement existed as in the making of iron, with the additional inconvenience arising from some portions of the metal becoming entirely decarbonized, and being converted into soft malleable iron.

Iron thus presented a most unfavorable contrast with the other malleable metals, all of which were free from sand or scoria; they had no hard and soft parts, and required no welding together of separate molecules, but they were perfectly homogeneous and free from all mechanical admixture with foreign substances. Gold, silver, copper, zinc, tin, and lead, owed this valuable exemption from the defects universally found in puddled iron, simply to the fact that they were purified and refined in a fluid state, and, while still fluid, were formed into ingots, whereby the cohesion of every particle in the mass was insured. If, then, the refining of other malleable metals, while in a fluid state, and their formation into cast ingots, rendered all such metals more sound and homogeneous than iron, while it did not lessen their extreme

* From the Lond. Artizan, July, 1859.

ductility, why should iron for ever remain an exception to the general rule? It might be truly answered that hitherto the excessively high temperature required to fuse and to maintain pure iron in a fluid state, had interposed an insuperable barrier, for the highest heat of the furnaces only sufficed to show that fluidity was a possible condition of that metal.

It need not, therefore, be a matter of surprise that when Mr. Bessemer first proposed to convert crude pig iron into malleable iron, while in a fluid state, and to retain the fluidity of the metal for a sufficient time to admit of its being cast into moulds without the employment of any fuel in the process, his proposition was looked upon by many as a chimera, or as the mere day-dream of an enthusiast; but it was, nevertheless, fully recognised and supported by many of the scientific men of the day. The same deep conviction of the truth on which the new process was based, and which led Mr. Bessemer to bring it before the British Association in 1856, had since determined him (in spite of the opinions then pronounced against the process) to pursue one undeviating course until the present time, and to remain silent for years under the expressed doubts of those who predicted its failure, rather than again bring forward the invention until it had been practically and commercially worked, and there had been produced by it both iron and steel of a quality which could not be surpassed by any iron or steel made by the tedious and expensive processes now in general use.

The want of success which attended some of the early experiments was erroneously attributed by some persons to the "burning" of the metal, and by others to the absence of cinder, and to the crystalline condition of cast metal. It was almost needless to say, that neither of the causes assigned had any thing to do with the failure of the process in those cases where failure had occurred. Chemical investigation soon pointed out the real source of difficulty. It was found that although the metal could be wholly decarbonized, and the silicum be removed, the quantity of sulphur and of phosphorus was but little affected; and, as different samples were carefully analyzed, it was ascertained that red shortness was always produced by sulphur when present to the extent of 1-10th per cent., and that cold shortness resulted from the presence of a like quantity of phosphorus; it therefore became necessary to remove those substances. Steam and pure hydrogen gas were tried with more or less success in the removal of sulphur, and various fluxes composed chiefly of silicates of the oxide of iron and manganese, were brought in contact with the fluid metal during the process, and the quantity of phosphorus was thereby reduced. Thus many months were consumed in laborious and expensive experiments; consecutive steps in advance were made, and many valuable facts were elicited. The successful working of some of the higher qualities of pig iron caused a total change in the process, to which the efforts of Messrs. Bessemer and Longsdon were directed. It was determined to import some of the best Swedish pig iron, from which steel of excellent quality was made, and tried for almost all the uses for

which steel of the highest class was employed. It was then decided to discontinue, for a time, all further experiments, and to erect steel works at Sheffield for the express purpose of fully developing and working the new process commercially, and thus to remove the erroneous impressions so generally entertained in reference to the Bessemer process.

In manufacturing tool steel, the highest quality, it was found preferable for several reasons to use the best of Swedish pig iron, and, when converted into steel by the Bessemer process, to pour the fluid steel into water, and afterwards to remelt the shotted metal in a crucible, as at present practised in making blister steel, whereby the small ingots required for this particular article were more perfectly and more readily made.

It was satisfactory to know that there existed in this country, vast and apparently inexhaustible beds of the purest ores fitted for the process. Of the hematite alone 970,000 tons were raised annually, and this quantity might be doubled or trebled whenever a demand arose. It was from the hematite pig iron made at the Workington Iron Works, that most of the larger samples of iron and steel exhibited were made. About 1 ton 13 cwt. of ore, costing 10s. per ton, would yield 1 ton of pig metal, with 60 per cent. less lime and 20 per cent. less fuel than were generally consumed when working inferior ores; while the furnaces using this ore alone yielded from 220 to 240 tons per week, instead of, say 160 to 180 tons per week when working with common iron stone. The Cleator Moor, the Weardale, and the Forest of Dean Iron Works, also produced an excellent metal for this purpose.

The form of converting vessel which had been found most suitable, somewhat resembled the glass retort used by chemists for distillation. It was mounted on axes, and was lined with "Ganister" or road drift, which lasted during the conversion of thirty or forty charges of steel, and was then quickly and cheaply repaired or renewed. The vessel was brought into an inclined position to receive the charge of crude iron, during which time the tuyeres were above the surface of the metal. As soon as the whole charge was run in, the vessel was moved on its axes so as to bring the tuyeres below the level of the metal, when the process was at once brought into full activity, and twenty small though powerful jets of air sprung upwards through the fluid mass; the air expanding in volume divided itself into globules, or burst violently upwards, carrying with it a large quantity of the fluid metal, which again fell back into the boiling mass below.

The oxygen of the air appeared in this process, first, to produce the combustion of the carbon contained in the iron, and, at the same time, to oxidize the silicum, producing silicic acid, which, uniting with the oxide of iron, obtained by the combustion of a small quantity of metallic iron, thus produced a fluid silicate of the oxide of iron or "cinder," which was retained in the vessel, and assisted in purifying the metal. The increase of temperature which the metal underwent, and which seemed so disproportionate to the quantity of carbon and iron consumed, was doubtless owing to the favorable circumstances under

which combustion took place. There was no intercepting material to absorb the heat generated and to prevent its being taken up by the metal, for heat was evolved at thousands of points distributed throughout the fluid, and when the metal boiled the whole mass rose far above its natural level, forming a sort of spongy froth, with an intensely vivid combustion going on in every one of its numberless ever-changing cavities. Thus, by the mere action of the blast, a temperature was attained in the largest masses of metal in ten or twelve minutes, that whole days of exposure in the most powerful furnace would fail to produce.

The amount of decarbonization of the metal was regulated with great accuracy by a metre, which indicated on a dial the number of cubic feet of air that had passed through the metal; so that steel of any quality or temper could be obtained with the greatest certainty. As soon as the metal had reached the desired point (as indicated by the dial), the workmen moved the vessel so as to pour out the fluid malleable iron or steel into a founder's ladle, which was attached to the arm of a hydraulic crane, so as to be brought readily over the moulds. The ladle was provided with a fire-clay plug at the bottom, the raising of which, by a suitable lever, allowed the fluid metal to descend in a clear vertical stream into the moulds. When the first mould was filled, the plug valve was depressed, and the metal was prevented from flowing until the casting ladle was moved over the next mould, when the raising of the plug allowed this to be filled in a similar manner, and so on until all the moulds were filled.

The casting of large masses of a perfectly homogeneous malleable metal into any desired form, rendered unnecessary the tedious, expensive, and uncertain operation of welding now employed wherever large masses were required. The extreme toughness and extensibility of the Bessemer iron was proved by the bending of cold bars of iron, 3 ins. square, under the hammer into a close fold, without the smallest perceptible rupture of the metal at any part; the bar being extended on the outside of the bend from 12 ins. to 16¾ ins., and being compressed on the inside from 12 ins. to 7¼ ins., making a difference in length of 9½ ins. between what, before bending, were the two parallel sides of a bar 3 ins. square. An iron cable consisting of four strands of round iron, 1½ ins. diameter, was so closely twisted while cold, as to cause the strands at the point of contact to be permanently imbedded into each other. Each of these strands had elongated 12½ ins. in a length of 4 ft., and had diminished one-tenth of an inch in diameter, throughout their whole length. There were also exhibited some steel bars, 2 ins. square, and 2 ft. 6 ins. in length, twisted cold into a spiral, the angles of which were about 45 degrees; and some round steel bars, 2 ins. in diameter, bent cold under the hammer, into the form of an ordinary horse-shoe magnet, the outside of the bend measuring 5 ins. more than the inside.

The steel and iron boiler plates, left without shearing and with their ends bent over cold, also afforded ample evidence of the extreme tenacity and toughness of the metal; while the clear even surface of the

railway axle and piece of malleable iron ordnance, were examples of the perfect freedom from cracks, flaws, or hard veins, which formed so distinguishing a characteristic of the new metal. The tensile strength of this metal was not less remarkable, as the several samples of steel tested in the proving machine at Woolwich Arsenal, bore, according to the reports of Colonel Eardley-Wilmot, R. A., a strain varying from 150,000 lbs. to 162,900 lbs. on the square inch, and four samples of iron boiler plate, from 68,314 lbs. to 73,100 lbs.; while, according to the published experiments of Mr. W. Fairbairn, Staffordshire plates, bore a mean strain of 45,000 lbs., and Low Moor and Bowling plates, a mean of 57,120 lbs. per square inch.

There was another fact of great importance in a commercial point of view. In the manufacture of plates for boilers and for ship-building, the cost of production increased considerably with the increase of weight in the plate; for instance, the Low Moor Iron Company demanded £22 per ton for plates weighing 2½ cwt. each, but if the weight exceeded 5 cwt., then the price rose from £22 to £37 per ton. Now, with cast ingots such as the one exhibited, and from which the sample plates were made, it was less troublesome, less expensive, and less wasteful of material, to make plates weighing from 10 to 20 cwt. than to produce smaller ones, and, indeed, there could be but little doubt that large plates would eventually be made in preference, and that those who wanted small plates would have to cut them from the large ones. A moment's reflection would therefore show the great economy of the new process, in this respect; and, when it was remembered that every riveted joint in a plate reduced the ultimate strength of each 100 lbs. to 70 lbs., the great value of long plates for girders, and for ship-building, would be fully appreciated.

At a time when the manufacture of ordnance occupied so large a share of public attention, it was interesting briefly to point out the great facility which the Bessemer process afforded of forming masses, both of malleable iron and of steel, of a size suitable for the heaviest ordnance, without any welding together of separate slabs, or the more costly mode of building up the gun with pieces accurately turned and fitted together. Many attempts had been made to produce wrought iron ordnance, and this object had been successfully accomplished in the case of the large gun produced at the Mersey forge. But, however perfect this one gun might be, the time required to make it, and its immense cost, manifestly rendered it still a great desideratum to produce guns rapidly and cheaply of a material equal to, or greater in tensile strength than wrought iron, and, if possible, free from the liability which that material had to flaws and to deterioration, during its long exposure to a welding heat. It was believed that the Bessemer process supplied this desideratum, as masses of cast malleable metal could be produced of 10 or 20 tons in weight in a single piece, and two or three such pieces might be conveniently made by the same apparatus in one day. The metal so made might be either soft malleable iron or soft steel. In order to prove the extreme toughness of such iron, and the strain to which it might be subjected without burst-

ing, several cast and hammered cylinders were placed cold under the steam-hammer, and were crushed down without the least tearing of the metal, as was shown by the samples exhibited. These cylinders were drawn from a round cast iron ingot of only 2 ins. greater diameter than the finished cylinder, and in the precise way in which a gun would be treated; they might, therefore, be considered as short sections of an ordinary 9-pounder field-piece. The tensile strength of the samples, as tested at the Royal Arsenal, was 64,566 lbs. per sq. in., while the tensile strength of pieces cut from the Mersey gun gave a mean of 50,624 lbs. longitudinally, and 43,339 lbs. across the grain; thus showing a mean of 17,550 lbs. per square inch in favor of the Bessemer iron.

If it was desired to produce ordnance by merely casting the metal, the ordinary founding process might be employed with the simple difference, that the iron, instead of running direct from the melting furnace into the mould, must first be run into the converting vessel, where in ten minutes it would become steel or malleable iron, as was desired, and the casting might then take place in the ordinary manner. The small piece of ordnance exhibited served to illustrate this important manufacture; and it was interesting in consequence of its being the first gun that was ever made in malleable iron without a weld or joint. The importance of this fact would be enhanced when it was known that conical masses of this pure tough metal, of from 5 to 10 tons in weight, could be produced at Woolwich at a cost not exceeding £6 12s. per ton, inclusive of the cost of pig iron, carriage, remelting, waste in the process, labor, and engine power. The conical ingots being cast in iron moulds, the great delay in moulding in loam would be avoided; and as the iron moulds employed might be removed from the casting pit within an hour after the metal had been poured into them, the tedious interval of three days now required by the cast iron guns before removal would be also avoided, thus immensely increasing the capabilities of the foundry.

If it was assumed that these advantages were about equal to the cost of hammering the cast ingot, then, by this process, it would be practicable to produce guns of any size, in hammered cast steel, or malleable iron ready for the boring mill, at about the same cost as the cast iron guns now in use; but if the weight of the guns could be reduced by 20 or 25 per cent., in consequence of their superior strength, then an actual saving in that proportion would be effected in the first cost of every gun so made. These important facts had been laid before the government, and their advantages were stated to be fully appreciated by Colonel Eardley-Wilmot, the superintendent of the Royal Gun Factories, who had evinced a great interest in the progress of the invention from its earliest date, and to whose kindness the author was indebted for the many valuable trials of the tensile strength of the various samples of metal that had been submitted for investigation.

It would be interesting to those who were watching the advancement of the new process to know that it was already rapidly extending itself over Europe. The firm of Daniel Elfstrand & Co., of Edsken, who

were the pioneers in Sweden, had now made several hundred tons of excellent steel by the Bessemer process. Another large manufactory had since been started in their immediate neighborhood, and three other companies were also making arrangements to use the process. The authorities in Sweden had fully investigated the whole process, and had pronounced in favor of it. The large steel circular saw plate exhibited, was made by Mr. Göranson, of Geffle, in Sweden, the ingot being cast direct from the fluid metal, within fifteen minutes of its leaving the blast furnace. In France, the process had been for some time carried on by the old established firm of James Jackson & Son, at their steel works, near Bordeaux. This firm was about to manufacture puddled steel on a large scale. They had already got a puddling furnace erected and in active operation, when their attention was directed to the Bessemer process, the apparatus for which was put up at their works last year; and they were now extending their field of operations by putting up more powerful apparatus at the blast furnaces in the Landes. There were also four other blast furnaces in the South of France in the course of erection, for the express purpose of carrying out the new process.

The irons of Algeria and Saxony had produced steel of the highest quality.

Belgium was not much behind her neighbors; the process was now being carried into operation at Liege, where excellent steel had been made from the native coke iron; while in Sardinia preparations were also being made for working the system. Russia had sent to London an engineer and a professor of chemistry to report on the process, and Professor Müller of Vienna, and M. Dumas and others from Paris, had visited Sweden to inspect and report on the working of the new system in that country.

The Bessemer process might, therefore, be now fairly considered an accomplished commercial fact, and in a country like England, where the manufacture of iron and steel formed so important a branch of the national industry, and was so necessary an element in all the great manufacturing operations, it must be admitted that an impartial examination of the new system was of the highest importance, not only to those immediately concerned in the production of malleable iron and steel, but to the country generally.

That the process admitted of further improvement, and of a vast extension beyond its present limits, the author had no doubt; but those steps in advance would, he imagined, result chiefly from the experience gained in the daily commercial working of the process, and would most probably be the contributions of the many practical men who might be engaged in carrying on the manufacture of iron and steel by this system. Hitherto the process had been brought into its present practical and commercial state, without recourse to any of the numerous inventions which were supposed by the several authors to be essential to the success of the system; but any real improvement that might be brought forward would be cordially received and encouraged.

*Robertson's Patent Chain Propeller.** By PETER SPENCE.

[Read before the British Association, 1859.]

At the request of the patentee and several gentlemen engaged in bringing this invention into practical operation, I have undertaken to give a short description of it to the Mechanical Section of the British Association.

It is well known that great efforts have been made to adapt steam power to the conveyance of both passengers and goods on canals, but although the failure of most of these efforts is apparent, from the fact that on a very few canals is it at this moment employed, yet there seems no reason to doubt that if steam power can be made to suit itself to the peculiarities of canal navigation, it will be found, as in every other department of mechanics, the cheapest and most convenient agent.

In 1831, when the first efforts seem to have been made to employ steam power on canals, Mr. Fairbairn, who was then engaged in an extensive series of experiments by which much valuable data was elicited, recommended for this purpose a peculiar form of steamboat with paddles in the stern; but however well these boats might otherwise have fulfilled the design, the surge from every form of paddle steamboat was no doubt the fatal barrier to their adoption. When at a later period the screw was adopted as a propeller, this seemed to meet the difficulties of the case, and screw propelled boats have to some extent been adopted and are now in use: but even the screw has been found only applicable to the few canals which are of considerable depth; and in these the danger always exists of a disturbance producing a disintegrating effect on the sides and bottom of the canal, and where, as in the majority of canals, the depth does not exceed 3 to 4 feet, the working of the screw is found to be altogether impracticable.

The invention of Mr. Robertson fully meets and obviates these difficulties arising from the use of both the paddle and the screw, while it possesses advantages in obtaining the full effect of the power applied, which are apparent at once. In whatever mode power is applied to the propulsion of vessels in water, by the paddle or screw, there is a great loss of power, only a part being productive, and the remainder wasted. For example, when the paddle is just entering the water on the one side, and leaving or emerging from it on the other, the powers expended in these actions only neutralize each other, and contribute nothing to the propelling of the vessel. So great is the loss of power in some circumstances, that one authority gives the following example:—Suppose a boat propelled in a stream, the power being affixed or applied to a cylinder on which a rope is wound, the other end of the rope being attached to a fixed point at some distance up the stream or on shore; and that the power is afterwards applied by paddles in the stream: it will, he says, take three times the motive power in the latter case that it does in the former to propel the vessel at the same speed. This, I think, must be an exaggerated estimate; but it clearly proves the great loss of power in certain cases, and the probability that it is considerable in all.

* From the Civ. Eng. and Arch Jour., Dec., 1859.

The peculiar principle of Mr. Robertson's invention is, that he applies the power by dragging the vessel from a fixed point, and its great ingenuity is, that the fixed point is at the same time a moveable one,—a constantly fixed point in relation to the power exerted in propelling the vessel, and a constantly changing point in relation to the course on which the vessel is being propelled. The construction of the propelling apparatus is as follows:—At or near the bows of a boat, say 70 feet long, is placed a steam engine, the main shaft of which crosses the bows of the vessel at or about the level of the deck; a fixed pulley is attached to each end of this shaft, these pulleys projecting over the sides of the vessel; they are 3 feet or more in diameter, and on their periphery have a hollow or groove to receive the chains which are to run over them; they are also so constructed as to take firm hold of the chains as the power is exerted in dragging them over the pulleys. On the other or the stern end of the boat are two pulleys, also projected over, one on each side; these are loose, so that the chains merely run over them. Friction rollers are also placed along each side of the vessel, to carry the chains as they pass from the stern to the bows of the vessel; the chains, which are endless, pass or are dragged over fixed pulleys at the bow of the vessel, and falling down lie along the bottom of the canal, and thus become the fixed point or lineal anchor on which the power acts; the action of the engine in dragging the chain over the loose and fixed pulleys being necessarily to drag or propel the boat forward. Every yard of the chain passed over the pulleys representing a yard of space that the boat has progressed in her course—the fixed point or length of chain lying at the bottom of the canal still remaining the same, what is taken up at the stern being replaced by exactly the same length deposited at the bow. The speed of the vessel is thus exactly equivalent to the speed and size of the driving pulleys, unless, indeed, there should be any slip of the chain in passing over them, and this in practice is easily prevented, and is again exactly measured by the velocity of the chain, unless there should be a slip of the chain along the whole length over the bottom of the canal, and this, of course, is a mere matter of the weight of the chain. In repeated trials which have been made before thousands of spectators (and in more than one of which the writer was on board), in a boat 70 feet long and 7 feet wide, the chain used was only 20 lbs. per yard, or 40 lbs. per yard for the two chains, 22 yards of double chain being always at the bottom; this gives a weight or resistance of 880 lbs. in this case as the fixed point. From the data ascertained by Mr. Fairbairn, that in tugging vessels the average pull of a horse was 94 lbs., the fixed point in these trials would exceed nine horses' power, and an engine power of nine horses could therefore be exerted without the chain slipping over the bottom of the canal. The speed attained ranged from 4 to 6 miles per hour, and nothing more was attempted at that time; the motion was easy and regular, the facility for starting equal to either screw or paddle, and the power of stopping quite peculiar. The moment the engine stops she drags at anchor, and the momentum is absorbed before the vessel has proceeded one-half of her own length.

The weight of the chain can be doubled or quadrupled without inconvenience, and the capability of using increased power to any extent be afforded as required. The weight of chain when increased does not materially increase the loss of power, as the power expended in raising the chains at the stern is neutralized by the weight of the falling chain at the bows, the only loss of power being the friction on the pulleys and friction rollers as the chains pass from stern to stem of the boat above water, and that must be so trifling as not to merit calculation. The invention is not limited in its application to canals, but is suited to rivers where occasional shallowness may render either paddles or screw useless, or where a strong current would prevent any amount of power being got except at an enormously increased and therefore impracticable speed. No additional speed, but only an additional power, would be required by the chain propeller to stem the strongest current; and however shallow, if the boat will float the propeller will work.

It is almost needless to add that the working of the chain gives rise to none of that commotion in the water that constantly attends the working of both paddles and screw; the chains rise and fall without the least perceptible agitation of the water, and even the ordinary wave from the bow of the boat is cut in pieces by the falling chain and reduced to the merest ripple.

Proceedings of the British Association for the advancement of Science.

29th Annual Meeting, Sept., 1859. (Continued from page 117.)

SECTION G.—*Mechanical Science.**

Monday, 19th.—"On a New Gas-Burner, and a Method of producing an Illuminating Gas cheaply from the Decomposition of Water," by the Abbé MOIGNO.

"On an Automatic Injector for feeding Boilers," by Mr. GIFFARD.

"On a Helico-Metre, an Instrument for Measuring the Thrust of the Screw-Propeller," by the Abbé MOIGNO.

"On an Application of the Moving Power arising from Tides to Manufacturing, Agricultural, and other Purposes, and especially adapted to obviate the Thames Nuisance," by Dr. SEGUIN.

"Description of the Granite Quarries of Aberdeen and Kincardineshire,' by Mr. A. GIBB.—The working of the quarries in Aberdeen commenced 250 years ago; but little progress was made for 100 years. The houses in Aberdeen were constructed principally of wood till 1741, when a fire taking place, the town-council ordained that the fronts of the houses should be built of stone or brick. In 1764 granite was recommended for paving the streets of London, and was used for Waterloo Bridge in 1817, and subsequently for the docks at Sheerness and London Bridge. There are upwards of twenty quarries supplying the different varieties of granite: the blue, the red or Peterhead granite, the light red, soft grey, and white. The granite, for the most part, lies in irregular masses in the quarries, and generally of columnar structure. The quarrying is principally carried on by blasting. The

* From the Lond. Athenæum, Oct., 1859.

drainage of the quarries is chiefly accomplished by means of siphons of lead-pipe, from 1 to 2 or 3 inches in diameter. The author suggests the use of a locomotive engine on rails for drainage purposes, as well as for crane and lifting work. The quarries are not worked to any great depth, though the best and largest masses are found at the lower depths; and proper mechanical contrivances for working deeper might be used with advantage. With reference to the durability of the granite, there appears no appreciable decay; on the oldest specimens of several hundred years the tool-marks are as sharp and fresh as at first. The tools used in dressing the granite for a long period were hammers, picks, and axes only; but in 1820 steel chisels were introduced, which effected a considerable improvement. Machinery was tried for dressing, but it failed, being in the form of a planing machine, the granite requiring a distinct blow to separate the parts. The number of workmen employed in the quarries is about 500 daily, and the number of horses about 50. About 50,000 tons are quarried annually, of which about 30,000 are exported; and the export is increasing at the rate of 500 tons annually.

"On a New Gas-Metre, with a Description of an Improved Method of obtaining a true Liquid Level," by Mr. A. ALLEN.

"On the Comparative Value of Propellers, with a Description of a Direct-Acting Propeller," by Mr. J. ROBB.

Mr. R. ROBERTS maintained that the screw and the paddle-wheel were not so imperfect in their action as Mr. Robb considered them; and he was of opinion that the paddle-wheel with radial floats was more effective than that with feathering floats. He considered a well-made screw as the most effective propeller. Mr. Robb's propeller was not new, and would soon go to pieces.—Mr. OLDHAM had seen the same thing tried and fail.—Mr. W. SMITH said a similar propeller had been made eighteen years ago, when it failed.—Mr. NEILSON did not agree with Mr. Roberts as to the relative merits of the radial and feathering paddles. In his experience the feathering wheels were the best.—Sir E. BELCHER said, that the vibration caused by the paddle-wheel arose from the back action on leaving the water, and not on entering.—Mr. OLDHAM thought that the friction gearing would be of value in driving the screw in the place of direct-acting engines.—Mr. NEILSON had had experience in friction gearing, and approved it. It was exciting much interest among the engineers on the Clyde.—Mr. G. RENNIE stated that he had tried friction gearing in the *Archimedes*, but it had failed. —Mr. DIXON had seen it tried in some rolling-mills, but it did not succeed.—Mr. W. FAIRBAIRN thought that it was worth consideration; though he feared that the great pressure necessary would cause much friction on the shaft, and thus waste power.

An experimental illustration of the Gyroscope was given by Mr. A. GERARD, who endeavored to explain its action by reference to more elementary principles of mechanics than were usually assumed for the purpose.

Tuesday, 20th.—"Experimental Researches to determine the Density of Steam at various Temperatures," by Mr. W. FAIRBAIRN.*

* See Journal of the Franklin Institute, page 17.

Prof. MACQUORNE-RANKINE and Dr. JOULE expressed their opinion of the great value of Mr. Fairbairn's researches, and trusted that he would continue them.

"On the Steam Machinery of the *Callao*, *Bogota*, and *Lima*," by Mr. J. ELDER.

"On Surface Condensation," by Dr. J. P. JOULE.—The author described the experiments he had made on this important subject. A peculiar arrangement he had introduced gave a very increased effect to a given surface. In this arrangement a copper spiral was placed in the water spaces. The spiral had the effect of giving the water a rotary motion, which was thus compelled to travel over a larger surface than it would otherwise. He also pointed out that he had succeeded in producing a better vacuum than the temperature of the condensing and condensed water appeared to warrant, and that thus a fresh and unexpected advantage was proved to belong to the system of surface condensation.

A discussion took place, in which Prof. MACQUORNE-RANKINE, Messrs. A. TAYLOR and W. SMITH took part; and a wish was expressed that Dr. JOULE would continue his important researches and give the results at a future meeting.

"On a Submarine Lamp," by Mr. RETTIE.

Mr. C. BARNETT explained the arrangement of his lamp for the same purpose.

"On the Advantages of the 40-inch Metre as a Measure of Length," by Mr. G. JOHNSTONE STONEY.—The author showed that if a 40-inch metre was adopted it could readily be decimalized and the inch retained, and thus all difficulty in the comparison of the old and new measure would be avoided. The tenth would be four inches, which he would call a hand, the hundredth he would call a nail, and the one-thousandth he would call a line. The old yard would thus be nine hands, a foot would be three hands, and one inch would equal twenty-five lines.

"On Gas Carriages, for lighting Railway Carriages with Coal Gas instead of Oil," by Mr. G. HART.

"On Coal-Pit Accidents," by Capt. J. ADDISON.

"On a Deep Sea Pressure Gauge," by Mr. H. JOHNSON.

Sir E. BELCHER explained an instrument constructed under his direction some years since for ascertaining the depth of water by compression, and also the temperature and the quality. He pointed out the difficulties to be got over in the construction of such instruments, and how he had succeeded in obviating them. His (Sir E. Belcher's) instrument had been tested to 1200 fathoms, and proved successful.

"On a Patent Disc Pan for evaporating Saccharine Solutions and other Liquids at a Low Temperature," by Mr. DAVIS.

Mr. A. TOPP described various Models of Fire-Escapes, Boats, &c.

"On Indian River Steamers and Tow-Boats, giving an Account of their improved Construction for Light Draft, capability for Cargo, and Fittings conducive to Managability in Shallow Rapid Rivers, &c., and of the Practical Value of the Dynamometer in showing the Resistance of Vessels in Tow, at Different Speeds and Loads, with the Result of Test-Trials made in England," by Mr. A. HENDERSON.

For the Journal of the Franklin Institute.

Collection of Observations on the Day-light Meteor of Nov. 15, 1859, *with remarks on the same.* By Benjamin V. Marsh.

This meteor made its appearance at about half past 9 o'clock, A. M., (New York time,) the weather being perfectly clear, and the sun shining brightly.

It was *seen* at Salem, Boston, and New Bedford, Mass.; Providence, R. I.; New Haven, and many other places in Conn.; New York City; Paterson, Medford, and Tuckerton, N. J.; Dover, and other places in Delaware; Washington City; Alexandria, Fredericksburg, and Petersburg, Virginia.

It was *heard* at Medford, New Jersey, and at *all* places in that State, south of a line joining Tuckerton and Bridgeton, and throughout nearly the whole of Delaware.

With perhaps two or three exceptions, it was *not seen* by any one in New Jersey, south of the Camden and Atlantic Railroad; that is to say, *throughout the very region where the report was loudest.*

Many persons there, saw a momentary flash of light "like the reflection of the sun from a looking-glass," but could not tell where it came from.

The appearance of the meteor at different places is described as follows:—

Salem, Mass.

Francis F. Wallis, pilot, saw it as he was rowing across the harbor. He says, "When first seen, it was bearing about S. W. at an elevation of about 45°. Its path was nearly a straight line, making an angle of about 40° with the vertical, tending westward. Its apparent size, one-sixth the surface of the full moon—its appearance, that of a star, and quite brilliant—color, light red—leaving a train like that of a rocket, which was visible nearly the entire time, from the meteor's first being seen, until it disappeared behind the land, which probably had an elevation of three degrees. The train was of a pale reddish hue—time, from five to eight seconds—no sound heard."

Boston, Mass.

"E. F. Kinsman saw a meteor fall in the woods, in the south part of Natick—a circular luminous body terminating in a cone-like appendage. The woods were searched, but no trace found."

Pawtucket, R. I.

Mr. Blanding says, "It appeared to fall into Narragansett Bay, near the city of Providence. When first seen, it was near the zenith, and it passed down with great velocity, until beyond his vision—the sun was shining brightly."

Middletown, Conn.

A passenger on the stage from Middletown to New Haven, says, "A ball of fire was seen to descend, with a gentle lazy motion, to the earth, within a few hundred yards of the stage. We made search, but found nothing. The light was peculiarly white, and the motion somewhat undulatory."

New Haven, Conn.

It was seen by several persons, whose observations have been carefully investigated by E. C. Herrick of Yale College, who says, "Judge W. W. Boardman was standing on the sidewalk in such a position that the meteor's path is excellently determined by means of terrestrial objects. On going to the place which he occupied, it is found, by compass and quadrant, that the bearing of the meteor, when first seen, was S. 29° W. at an elevation of 15° to 18°, that it shot obliquely down towards a more westerly point, making an angle of about 33° with the vertical, and disappeared behind a steeple, at an altitude of 6°, bearing S. 35° 34′ W. The meteor did not pass the steeple, which is quite narrow, and here subtends an angle of about two degrees. I cannot be sure of the angle made with the vertical within 5° or 10°. The meteor was not more than two, probably not over one and a half seconds in sight, and appeared about as large as the full moon. An observer in the northern part of the city, where there was no material obstruction, saw the meteor disappear above a distant house, the top of which I have ascertained to be just 2° above his horizon. The place of disappearance may have been a half or one degree higher."

Mr. H. also mentions an observer on the Woodbridge hills, who saw it disappear above the horizon.

Hartford, Conn.

The *Hartford Courant* says it was seen by E. D. Tiffany, and that "It appeared to him about two feet in diameter, with a luminous appendage differing from the tail of a comet, inasmuch as it tapered from the nucleus. He was so certain that a few minutes search would have found the meteor, that only want of time prevented his attempt to bring it home as a trophy. It is certain 'the thing' fell upon Connecticut soil."

On the Hudson near Fort Washington.

Capt. Adams, of the schooner *Tryall*, says, "I saw what seemed to be a ball of fire about as large as a man's hat, coming almost directly towards my vessel, from an angle of about 45°. It left a wake or tail of about 15 feet in length, clearing the vessel but a few feet, and struck the water with a hissing sound about fifty yards off our port bow, and was lost to sight."

New York.

It was seen by great numbers, nearly all of whom appear to have thought it fell very near them. The police in the Central Park thought it fell within that enclosure.

The *Post* says, "Nucleus 1 foot in diameter, and the length of the tail, by the same scale, about 20 feet; the shape being a cone tapering to a fine point at top. The color was that of a bright yellow fire, and its brilliancy may be estimated by the fact that this color developed itself above the brightness of the sun, shining at the time through a cloudless sky. It disappeared behind the houses so abruptly, that it must have struck the earth very near the city."

The *Times* says, "Resembling in shape an inverted balloon, with a a tail 100 feet in length trailing after it."

A gentleman on the Elizabethport steamer, was sure that it fell within a few feet of the stern of that vessel.

Prof. Loomis, in the January number of *Silliman's Journal*, from the estimates of several observers at New York, concludes that the point of the horizon where the meteor vanished, was 21° west of south, that the length of its visible path was from 15° to 25°, and that the entire period of its visibility did not exceed one or two seconds.

Newark, N. J.

Henry J. Mills estimated the inclination of the meteor's path to the vertical, to be about 45°.

Medford, N. J.

Robert B. Stokes was standing on the sidewalk in the shadow of the Burlington County Bank, engaged in conversation, when he saw the meteor *over* the building. Chas J. Allen, of Philadelphia, has recently visited the spot, and measured the bearings and elevations, as pointed out to him by Mr. S.

He states that Mr. S. was on the *east* side of a street which runs S. 1¾ W. and was looking eastward. Thinks the meteor when first seen was almost due east (which would require it to have had an elevation of at least 59° and probably 65°), but this direction is uncertain. If exactly south-east, the elevation may not have exceeded 48°. Mr. A. is inclined to adopt 30° S. of E. as the most probable direction of first appearance, at an elevation of about 58°.

It shot down towards the south, and disappeared behind a house about 500 feet distant, on the *west* side of the street, bearing S. 9½ W. at an altitude of 2½°.

Mr. S. thinks he remained in the open air three minutes longer, and then went into a house without having heard any report.

The sound was heard by many persons in that vicinity. One lady who was in the house heard it, and ran out thinking the chimney was on fire.

George Haines noted the time immediately after the sound *ceased*, and after making allowance for probable error of his watch, makes the time 9 35 A. M. He estimates its duration at two minutes.

Tuckerton, N. J.

Theophilus T. Price says, "A few persons in this vicinity saw a 'ball of fire,' as they express it, pass apparently from a very high region of the heavens, and from nearly overhead, and descend towards the earth in a south-westerly direction, very far off.

" Others saw only a flash of light, while a very large majority of those who heard the rumbling noise, saw nothing unusual previously. The concurrent testimony of those who saw the flash, or the meteor itself, fixes the time that elapsed between the appearance and the report, at between three and four minutes. This would make its distance from this place between forty and fifty miles, which agrees very well with other circumstances known in reference to it.

"At the time the event occurred, a number of workmen were repairing a bridge over Wading River, nine miles westward of this place. The foreman, a man of veracity and intelligence, informed me that

himself and those that were with him, had a distinct view of the fall of the meteor. There being very little wind, the surface of the river was smooth, and, while busily engaged above it, they were suddenly startled by a flash of light upon the water beneath them, and looking up, beheld a 'ball of fire' receding and descending in the distant south-west. The foreman looked at his watch, and remarked that it was twenty minutes to ten o'clock. Presently, they were again startled by the roaring, rumbling, or rushing noise, which seemed to jar the air around them, and which so many thousands of persons in Southern New Jersey heard with wonder and even with terror.

"Either during the continuance of this noise, or at its close (I do not recollect which my informant stated), he looked at his watch again, and found the time sixteen minutes to ten. He says that the meteor exploded and disappeared before it reached the horizon, and that it had a short train or tail. It disappeared perhaps within ten degrees of the horizon.

"This account is concurred in by his workmen, and coincides with another related by a woodman near Tuckerton, who was in the act of felling a tree, and looking up to see which way it would fall, saw, as he says, 'a large ball of fire' shoot out of the sky, and sink away in the south-west. He was very much frightened, and spoke of it to a gentleman who came up immediately after, who says that three or four minutes elapsed before the terrible roaring began.

"The next week after the phenomenon occurred, I was in the southern part of this State, and as far south as Cape Island; and wherever I went, it was the common subject of conversation. At Tuckahoe and Marshallville on Tuckahoe River, the noise was said to proceed from a cloud of smoke, very high, nearly or quite overhead; while in the middle and lower parts of Cape May County, it was invariably spoken of as being in the north. Several persons in various parts of Cape May County saw the cloud of smoke, but I heard of none who saw the meteor itself."

Mr. Price further says, "I venture the opinion that the meteor came from far beyond our atmosphere, and struck it some distance north-east of the place of its disappearance, passing in a south-west direction towards the earth at an angle of less than forty-five degrees from the perpendicular. If an aerolite, it must have fallen to the earth somewhere in the vicinity or south of Tuckahoe River. I would place its locality somewhere in the forests between Tuckahoe and Maurice Rivers. It is possible that it reached the Delaware Bay in Maurice River Cove, but this I do not think very probable, from the fact that the cloud of smoke seemed nearly or quite vertical at Marshallville."

Again. "The sky was perfectly cloudless, and the wind blowing lightly from the south-west. The noise is variously described, as resembling the quick and *successive* discharges of artillery, the rumbling of a train of cars over a wooden bridge, or the prolonged roar of distant thunder. It continued more than a minute. The noise proceeded from the south-west, and appeared to such as were in the open air, to be above the earth."

Georgetown, Del.

Dr. D. W. Maull says, "Two persons in this vicinity witnessed it, who say it appeared to fall on the ground, not 100 yards from the place where they stood—a noise like the rumbling of the cars on the iron track.—It shook the ground sensibly.—Several minutes, say from four to five, between the flash and report.—The meteor was like a round ball of fire, very brilliant, about the size of one's head, with a tail at least ten feet long, which was quite as bright as the body.—No cloud or smoke observed."

A letter from Baltimore Hundred, in this county, states that, "Several teams were in the road, and the oxen suddenly sprang as though frightened, and the drivers were nearly blinded, and a something was perceived, going through the air, six inches in diameter, with an appendage fifteen feet long, with the forward end a-blaze—all of which settled in a field near by. This was witnessed by a number of people."

Washington, D. C.

J. S. M. writes to the *National Intelligencer*, "Coming in from Georgetown, and being on the north side of the Avenue, very near the western angle of the inclosed space at the intersection of I street, I was startled by the appearance of a meteor of unusual size and brilliancy. Walking eastward, but looking down the Avenue, the vividness of the meteoric light was so intense as to attract my vision from that direction, to the line of I street, immediately over the central part of Senator Gwin's mansion. The meteor itself was a clearly defined object, of a light almost as dazzling as the sun, and of a diameter perhaps three-fourths that of the full moon as seen in the zenith. Surrounding the nucleus of the meteor, was a luminous band of apparently twice its own diameter, and extending vertically 15° to 20°; terminating, however, not in the expanding form of meteoric trains, as generally seen, but in a clear sharp point. Indeed, the whole train of light was singularly well marked against the sky, without nebula or scintillations, excepting that to the northward, and in almost touching proximity to the base of the meteor, there was a companion-ray of light, but of a red color, traveling with it.

"When my eye first caught sight of the object, its base was about 30° from the horizon, and the direction of its track was strictly vertical. It was, perhaps, two seconds in view, for I had time, after seeing it first, to grasp my companion's arm and point to it before it disappeared behind Mr. Gwin's house. My friend had, however, seen it, and his description of it is, that it was like a *huge maul* of fire falling from the sky. The time of observation was precisely twenty minutes past nine, A. M. Without professing scientific lore, it strikes me that the most singular features of this phenomena, were its marvellous brilliancy—so near the sun as it was—and the sharp *artificial* character of its contour."

J. S. L., in the *Union*, says that he was in the open fields, and on high ground affording an uninterrupted horizon, near Glenwood Cemetery, and saw "a meteor falling almost perpendicularly from the heavens. It seemed to fall about four miles from me, in a N. E. direction—ap-

peared to reach the ground. There was a perpendicular line of fire about 100 yards long, with a massive ball of fire at the lower end, about the size of a barrel, and shaped like an inverted balloon."

Prof. Henry says, "I have, myself, verified, on the large map of the city, the direction of the meteor as seen by Mr. Marion Force, one of the assistants in the Smithsonian Institution. He pointed out the precise place on the map where he stood, and the point at which it appeared to descend, and find that the latter bears 4° N. of E. from the former. I have also examined the position of the other observer, J. S. M., on the large map, and find the two observations very nearly agree as to the direction of the disappearance of the meteor; the observation of the latter differing not more than one degree farther north than the former. On questioning Mr. Force particularly as to the perpendicular descent of the meteor, he concludes that it was slightly oblique to the horizon, and apparently descended to the ground, a little north of the foot of the vertical through the point of its first appearance."

A communication, signed "H" in the *National Intelligencer*, referring to the same observation, says, "The meteor first caught the eye of the observer at an elevation of about fifty degrees."

(To be Continued.)

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A. M.,

Professor of Civil Engineering in the Philadelphia High School.

The importance of a knowledge of the peculiarities of our climate to the physician, the agriculturalist, and the engineer, has long been acknowledged. The physician compares the prevalent diseases of a month with the climatic conditions of the same period, and hopes thereby to obtain a clue to the cause of a disease, or a hint in regard to the means of preventing or counteracting it. The agriculturalist looks over the almanac anxiously, but in vain, to ascertain what kind of weather may be expected at a certain time, so that he may with confidence sow his seed, or refrain for a more favorable opportunity. The engineer and builder learn by close observation of the weather, that a certain period is favorable to the commencement of their operations, which, if neglected, will throw them back perhaps a month or more. So the political economist, taking into view all these circumstances, may draw from them conclusions in regard to time and causes, which may have great influence on the general wealth and health of the community.

In order that a permanent record of the meteorological changes observed may be preserved, I propose, in addition to the general tables furnished by the Committee on Meteorology, to give a general review of the points of interest in each month, and compare the month or season of the current year, with the corresponding month or season of the last year, and of the preceding nine or ten years.

January.—The year 1860 opened with very cold weather, the thermometer, on the morning of the 2d, marking but $3\frac{1}{2}$ degrees above

zero of Fahrenheit's scale. The weather soon moderated, however, and, after a snow storm on the 4th, and a rain storm on the 7th, became remarkably mild. There was a large quantity of floating ice in the Delaware River during the first week of the month, which occasioned some inconvenience to vessels passing up and down; but it had almost entirely disappeared before the middle of the month.

On the 10th, the Schuylkill River was entirely open below the Dam. On the 11th, over half an inch of rain fell; and on the 14th, nearly an inch and a quarter, completely clearing the ice and snow from the streets and rivers.

On the 26th, snow fell, covering the ground to the depth of about an inch and a half; and again on the 31st, to the depth of about seven inches. Both of these deposits, when melted, gave a depth of water of two-thirds of an inch.

The thermometer was lowest on the 2d, and highest on the 21st, when it reached 58°; though the warmest day was the 25th, when the mean temperature was 48·3°.

The barometer was highest on the 5th, when, being reduced to the temperature of 32°, it marked 30·399 inches; and lowest on the 17th, marking 29·593 inches.

There were but two days of the month entirely clear or free from clouds at the hours of observation, and five days on which the sky was entirely covered with clouds.

Comparison of January, 1860 *and* 1859, *with the month of January for nine years.*—The table given below, will exhibit at a glance the difference in the readings of the barometer and thermometer, the direction of the wind, and the quantity of rain which fell in January last; as compared with January of last year, and with the averages of the same month for the nine years from 1852 to 1860, inclusive.

A Comparison of the Principal Meteorological Phenomena of January, 1860, *with those of January,* 1859, *and of the same month for nine years, at Philadelphia.*

	Jan. 1860.	Jan. 1859.	Jan. 9 years.
Thermometer.—Highest,	58°	55°	62°
" Lowest,	3½	—2	—5½
" Daily oscillation,	14·8	13·0	11·9
" Mean daily range,	6·5	8·0	6·9
" Mean at 7 A. M.,	28·9	30·0	27·2
" " 2 P. M.,	38·4	38·6	35·2
" " 9 "	33·0	33·3	30·8
" " for the month,	33·4	34·0	31·1
Barometer.—Highest,	30·399 ins.	30·475	30·704
" Lowest,	29·593	29·387	28·941
" Mean daily range,	·159	·206	·206
" Mean at 7 A. M.,	29·970	30·016	29·978
" " 2 P. M.,	29·915	29·975	29·940
" " 9 P. M.,	29·938	30·017	29·965
" " for the month,	29·941	30·003	29·961
Rain and melted snow.	3·351 ins.	5·230	2·933
Prevailing winds.	N. 89° W. 402.	N. 80¾° W. 375.	N. 65½° W. 340.

For the Journal of the Franklin Institute.

Particulars of the Steamer New London.

Hull built by George Greenman & Co., Mystic, Conn. Machinery by C. H. Delamater, New York. Intended service, New York to New London, Conn.

HULL.—			
Length on deck, . . .		145 feet.	
" at deep load line, . .		135 "	
Breadth of beam, molded, . . .		26 "	
Depth of hold to spar deck, . .		8 "	6 inches.
Frames—molded, 12 ins.—sided, 8 and 9 ins.—apart at centres, 24 ins.			
Draft of water,	forward, 9 feet, aft,	10 "	
Tonnage, . . .	260.		
Area of immersed section at load draft of 10 ft.,	224 sq. ft.		
Masts, three. Rig, schooner.			
ENGINE.—Vertical direct.			
Diameter of cylinder, . . .			34 inches.
Length of stroke, . . .		2 feet	6 "
Cut-off—one-third.			
BOILER.—One—Return tubular.			
Length of boiler, . . .		18 feet.	
Breadth " . . .		8 "	8 inches.
Number of furnaces, . .	2.		
Breadth " . .		3 "	3 "
Length of grate bars, . . .		7 "	
Number of flues,	above, 16—below, 10.		
Internal diameter of flues,	above, . .		8 "
	below, 8 of 9½ ins., 2 of		16 "
Length of flues,	above, 12 ft. 10 ins.—below, .	9 "	8 "
Heating surface, . .	1100 sq. ft.		
Diameter of smoke pipe, . . .		3 "	
Height " . .		24 "	
PROPELLER.—			
Diameter of screw, . . .		9 feet.	
Length " . . .		1 "	6 inches.
Pitch " . . .		17 "	
Number of blades, . . .	4.		

Remarks.—One independent steam, fire, and bilge pump. Poop cabin and deck. Date of trial, October, 1859. C. H. H.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, February 16, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from T. Oldham, Esq., Superintendent of the Geological Survey of India, and John B. Murray, City of New York.

Donations to the Library were received from the Royal Astronomical Society, the British Meteorological Society, the Royal Society, the Statistical Society, and the Commissioners of Patents, London; the Royal Irish Academy, Dublin, Ireland; l'Ecole des Mines, Paris, France; Oesterreichischen Ingenieur-Veriens, Wien, Austria; the Governor-General of India, Calcutta, India; L. A. Huguet-Latour,

Montreal, Canada; E. S. Philbrich, Esq., Boston, Massachusetts; the American Institute, City of New York; Wm. E. Morris, Esq., Brooklyn, New York; the Mercantile Library Association, Pittsburgh, Pennsylvania; and from Messrs. H. P. M. Birkinbine, Alfred B. Taylor, Col. J. Ross Snowden, Drs. William P. Moon, Laurence Turnbull, and Professors J. F. Frazer, and J. C. Cresson, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of January, was read.

The Board of Managers & Standing Committees reported their minutes.

Candidates for membership in the Institute (6) were proposed, and the candidates proposed at the last meeting (10) duly elected.

The Standing Committees for the ensuing year were appointed by the President, and approved as follows:—

On the Library.	*On Cabinet of Models.*	*On Cabinet of Minerals, &c.*
John Allen,	Wm. B. Bement,	Isaac H. Conrad,
James H. Cresson,	Joseph Buffington,	John F. Frazer,
George Erety,	George Burnham,	Frederick A. Genth,
B. B. Gumpert,	Richard H. Downing,	Isaac B. Garrigues,
Raper Hoskins,	John Fraser,	John L. Le Conte,
James T. Lukens,	Robert H. Gratz,	B. Howard Rand,
Samuel Middleton,	George C. Howard,	Robert E. Rogers,
Henry K. Plumly,	Ephraim L. Pratt,	J. Hamilton Slack,
John S. Sleep,	John L. Perkins,	John C. Trautwine,
Laurence Turnbull.	Coleman Sellers.	Wm. M. Uhler.

On Cab. of Arts & Manuf.	*On Exhibitions.*	*On Meetings.*
James C. Booth,	John E. Addicks,	Wm. B. Atkinson,
Thomas Bickerton,	John Agnew,	Charles S. Close,
Samuel Broadbent,	James H. Bryson,	James Dougherty,
Henry Bowers,	James H. Cresson,	Joseph S. Elkinton,
John B. Betts,	John M. Gries,	Henry Howson,
Robert C. Cornelius,	William Harris,	Washington Jones,
Edward P. Eastwick,	Thomas S. Stewart,	Thomas E. McNeill,
David M. Hogan,	William Sellers,	Andrew Palles,
Henry J. Taylor,	Isaac S. Williams,	B. Howard Rand,
Henry P. Taylor.	Thomas J. Weygandt.	John E. Wootten.

On Meteorology.

Chas. J. Allen,	J. Aiken Meigs,
Chas. M. Cresson,	Benjamin V. Marsh,
John F. Frazer,	Fairman Rogers,
Jas. A. Kirkpatrick,	James S. Whitney,
Alfred L. Kennedy,	Thomas J. Weygandt.

Mr. Peirce exhibited and explained the Low-water Detector manufactured by E. H. Ashcroft. It consists of a tube attached to the boiler, just below the water-level, extending vertically to a convenient height, and surmounted by an air-vessel. Just below the air-vessel projects a branch which contains a union-joint arranged to receive a disc of fusible alloy; beyond the disc is a steam-whistle. In the vertical tube is placed a cock, which is intended to prevent the continued escape of steam. The operation of the apparatus is as follows:—

After the boiler has been filled to the water-line, and put in action, the pressure of the steam forces the water up through the instrument into the air-chamber, compressing the air therein and filling this cham-

ber to a greater or less extent, according to the pressure. There being no circulation through the apparatus, so long as the lower end of the tube remains *under* water, its contents will be of a comparatively low temperature, and the disc will remain solid. But whenever the water in the boiler falls *below* the end of the tube, the steam immediately displaces the water in it, and melts the fusible disc, and rushing out through the opening, gives notice through the whistle that the water is falling to a dangerous point. To replace a disc, open the cock cautiously until the water reaches the opening at the top, then shut the cock, and when the water above it has become cool, the disc may be replaced with safety, and the cock fully opened.

The Committee on Meetings placed upon the Exhibition Table, a Model of Fawkes' American Steam Plough, presented to the Institute in accordance with the conditions of the award of the Scott's Legacy Premium. A description by the Committee on Science and Art, was published in the Report made by them, and published in the *Journal.*

No more satisfactory evidence of the superior claims and merits of this invention can be given, than that contained in the reports and awards of the following committees and societies, all of whom witnessed the Plough in practical operation, and subjected it to the most severe tests:—

Franklin Institute of Philadelphia, *Scott Legacy Premium of* $20 *and Medal.*

A Committee of the Pennsylvania State Agricultural Society, *Favorable Report.*

The Philadelphia Society for the Promotion of Agriculture, *Grand Gold Medal and Report.*

Illinois State Agricultural Society, $500 *Premium in* 1858, and $1500 *Premium in* 1859.

United States Agricultural Society, at their Seventh Annual Exhibition at Chicago, *Grand Gold Medal of Honor.*

Illinois Central Railroad Company, $1500 *Premium* and *Report corroborating the above awards.*

American Institute at New York, *Premium of* $1000.

A Committee of Scientific and Practical Machinists, appointed by the Illinois State Agricultural Society, and of the Illinois Central Railroad Company, recommend the award of the Premium of $1500 offered by Illinois R. R. Company.

Also, a working model of Mahlon Reeder's Self-acting Switch for turn-outs of railroads. It is operated by the weight of the car depressing one rail, which inclines upwards sufficiently to give motion during its descent to the switch, by means of rods and levers.

Mr. I. N. Hobbs exhibited and explained a working model of an elevator for Hotels, styled a Steam Reciprocating Stairway Two platforms are arranged to rise and fall by means of screws worked by belts from one landing to the next, pausing at each long enough, say ten seconds, until the passengers can step from one to the other. The edges of the platforms upon the open or entering side, as well as that of the landing, are hinged to prevent any part of the person being caught between them.

Abstract of Meteorological Observations for December, 1859, made in Philadelphia, Adams, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.

1859. Dec.	Barometer. Mean.	Barometer. Mean daily range.	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
1	29·852	·080	57·7	24	8·0	·380	55		S W.
☽ 2	29·812	·040	62·8	17	5·2	·551	75		S W.
3	30·261	·449	32·8	23	30·0	·120	61	} 0·475	N E.
4	30·076	·186	34·2	11	2·7	·193	95		N E.
5	30·146	·070	36·8	7	2·7	.207	90	0·007	N E.
6	30·031	·115	46·0	15	9·2	·323	93	0·128	N E.
7	29·701	·330	53·3	30	16·0	·510	88	0·464	(var.)
8	30·064	·363	24·5	14	28·8	·069	68		N W.
○ 9	30·129	·182	25·3	14	5·2	·069	55		S W.
10	30·057	·135	26·3	10	5·7	·074	48		N W.
11	29·869	·191	30·0	17	7·7	·129	61		S W.
12	29·716	·228	30·7	12	6·0	·149	70		(var.)
13	30·096	·380	27·5	13	6·5	·106	62		N E.
14	29·915	·180	30·3	7	3·2	·139	83	0·046	N E.
15	30·017	·121	30·7	11	2·3	·129	66		N W.
☾ 16	30·101	·085	29·5	13	3·5	·127	62		N N E.
17	29·809	·292	36·3	16	6·8	·188	85	1·305	N E.
18	29·684	·196	42·3	7	6·7	·216	72		S W.
19	29·816	·131	40·8	13	2·8	·166	52		S W.
20	29·540	·276	40·0	8	3·2	·244	91	0·450	(var.)
21	29·805	·282	33·3	13	6·7	·116	55		W.
22	29·906	·160	26·7	10	6·7	·112	67		W N W
23	29·813	·092	25·7	9	1·0	·112	67		W.
● 24	29·898	·089	20·5	10	5·2	·079	66		W.
25	29·892	·142	26·7	17	7·5	·112	67		S W.
26	29·671	·221	42·3	22	15·7	·172	46		S W.
27	30·065	·394	31·7	20	10·7	·106	50		N W.
28	30·188	·123	13·3	16	18·3	·074	91	0·020	N E.
29	30·035	·153	13·7	9	3·0	·065	81	0·565	N E.
30	29·766	·288	29·2	18	15·5	·149	84		(var.)
31	29·967	·201	22·2	15	7·0	·071	55		(var.)
Means	29·926	·199	33·0	14	8·4	·171	69½	3·460	N38°W.

GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 feet. Prof. M. JACOBS, Obs.

1859. Dec.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g. winds
	Inch.	Inch.	°	°	Inch.	Direc.
1	29·414	·189	51·7	14·0		S W.
2	20·418	·029	60·3	8·7		S S W.
3	29·933	·515	27·7	32·7	} 1·178	N N E.
4	29·720	·213	32·0	5·0		N E.
5	29·791	·071	33·7	1·7	} 0·375	N E.
6	29·643	·148	36·3	2·7		N E.
7	29·387	·256	34·7	9·7		(var.)
8	29·765	·378	16·0	18·7		N W.
9	29·742	·182	18·7	5·3		S W.
10	29·703	·153	24·5	5·8		(var.)
11	29·437	·267	30·0	5·5		S W.
12	29·293	·229	30·3	6·3		(var.)
13	29·710	·417	25·7	6·7		N E.
14	29·578	·132	27·3	1·7	0·028	N N E.
15	29·666	·101	26·0	3·3		N W.
16	29·706	·076	25·0	5·7		S.
17	29·256	·451	32·0	7·0	0·830	N N E.
18	29·223	·214	36·7	4·3		S S W.
19	29·421	·198	37·3	4·3		S W.
20	29·184	·238	34·3	5·0	0·455	(var.)
21	29·440	·262	25·0	6·3		N W.
22	29·466	·128	21·7	6·3		S.
23	29·407	060	17·7	4·0		(var)
24	29·542	·135	15·0	2·7		N W.
25	29·400	·182	21·3	9·0		S S W.
26	29·257	·226	39·7	15·3		S S W.
27	29·691	·434	30·3	9·3		(var.)
28	29·773	·082	15·3	15·0	} 0·660	N E.
29	20·609	·176	10·5	4·8		N E.
30	29·368	·267	22·0	11·5		S W.
31	29·615	·247	17·0	7·3		W N W
Means	29·536	·213	28·3	8·0	3·526	N57°W

SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2196 feet. GEO. MOWRY, Observer.

1859. Dec.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds.
	Inch.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	27·602	·065	61·3	10·0	·462	65	0·545	W S W.
2	27·647	·066	54·7	6·7	·475	69		(var.)
3	27·898	·252	27·0	27·7	·167	100	1·100	W N W
4	27·722	·177	38·7	11·7	·255	81		E.
5	27·781	·060	40·3	2·3	·297	85		S.
6	27·659	·122	42·3	6·7	·244	91	0·361	S.
7	27·575	·129	24·7	17·7	·110	86	0·048	W.
8	27·804	·229	11·3	13·3	·063	67		W N W
9	27·816	·146	19·3	10·7	·134	87		W.
10	27·800	·105	18·0	7·3	·104	79		(var.)
11	27·560	·240	29·7	11·7	·176	85		W.
12	27·388	·191	23·7	11·3	·105	85		W.
13	27·650	·262	22·3	6·7	·116	80		S E.
14	27·024	·026	27·0	4·7	·168	89		W.
15	27·609	·075	25·0	2·0	·147	78		W.
16	27·686	·024	26·7	7·7	·170	80		(var.)
17	27·274	·412	33·3	7·3	·204	100	0·670	E.
18	27·317	·178	31·7	3·7	·181	100	0·037	W S W.
19	27·498	·181	31·3	1·7	·155	79		(var.)
20	27·227	·271	30·0	2·0	·161	89	0·430	(var.)
21	27·521	·205	19·0	11·0	·085	72	} 0·155	W.
22	27·498	·102	18·0	5·0	·104	79		W S W.
23	27·457	·060	15·7	3·7	·105	85		W.
24	27·576	·120	10·3	5·3	·059	66		W.
25	27·489	·159	29·3	19·0	·143	66		S W.
26	27·408	·195	40·7	14·0	·208	92		W.
27	27·733	·325	29·3	11·3	·186	81		W N W
28	27·672	·061	20·0	9·3	·110	86	0·270	E.
29	27·471	·201	18·3	9·7	·074	83	0·286	S S E.
30	27·475	·166	27·3	12·3	·140	88		W.
31	27·653	·178	8·0	19·3	·061	73		W.
Means	27·586	·163	27·5	9·4	·170	82	3·902	S73°W.

Abstract of Meteorological Observations for December, 1859; made in Dauphin, Northumberland, Centre, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1859.	HARRISBURG, Dauphin Co. 40° 16′, N. 76° 15′, W. Height, 300 feet. JOHN HEISELY, M. D., Observer.						SHAMOKIN, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRIEL, Obs.				FLEMING, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. BRUGGER, Obs.				INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.				TARENTUM, Allegheny Co. 40° 37′ N. 79° 48′ W. Height 950 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermom.		Rain and Snow.	Prevail'g winds.	Thermom.		Rain and Snow.	Prevail'g winds.	Thermom.		Rain and Snow.	Prevailing winds.	Thermom.		Rain and Snow.	Prevail'g winds.	Thermometer.		Prevailing winds.
Dec.	Mean.	Mean daily range.	Mean	Mean daily range.			Mean.	Mean. daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	Inch.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	29·720	·120	53·8	10·3		E.	60·0	17·3		W.	52·3	13·0	0·060	(var.)	62·7	15·3	0·250	S.	61·0	14·0	S W.
☽ 2	29·711	·061	60·3	7·0		S W.	63·0	8·0		W.	47·3	13·0	0·200	E.	42·0	20·7	0·180	N W.	38·0	23·0	(var.)
3	30·234	·523	30·3	30·0	1·383	N E.	22·0	40·7	1·033	N.	23·7	28·7	1·120	E.	23·0	19·0	0·210	N W.	22·7	15·3	N E.
4	30·005	·230	34·3	4·7		N E.	35·0	12·7		N.	32·0	9·0		E.	38·3	15·3	0·100	S E.	36·3	13·0	?
5	30·064	·059	36·0	1·7		E.	34·3	1·7		(var.)	37·0	5·0		W.	39·0	4·7	1·280	S E.	40·7	4·3	N E.
6	29·940	·126	37·7	1·7	0·558	E.	42·3	5·7	0·255	S.	38·7	1·7	0·850	(var.)	49·0	10·7	0·590	S E.	49·7	9·0	S.
7	29·679	·271	37·3	5·0		(var.)	41·7	12·7	0·429	W.	31·0	11·7		W.	22·3	26·7	0·390	N W.	21·7	28·0	W.
8	30·038	·360	23·0	14·3		N W.	17·3	24·3		W.	16·0	15·0		N W.	7·0	15·3		N W.	16·0	8·3	W.
○ 9	30·032	·167	24·0	3·0		S W.	19·0	4·3		W.	22·3	8·3		W.	19·0	12·0		S W.	24·3	8·3	S W.
10	29·991	·125	29·0	5·0		N W.	20·0	5·0		W.	21·0	8·0		W.	17·0	6·0	0·004	N W.	19·3	7·7	(var.)
11	29·721	·270	30·7	3·0		S W.	24·3	12·3		(var.)	33·7	12·7		W.	30·3	10·0		S W.	33·0	10·3	S W.
12	29·576	·257	33·3	4·7		(var.)	30·7	15·7	0·015	W.	25·7	11·3	0·023	N W.	[illegible]	13·0		(var.)	24·7	13·0	W.
13	29·996	·419	26·0	7·3		E.	21·3	12·7		W.	22·7	9·7		E.	22·3	11·7		E.	25·0	9·7	(var.)
14	29·858	·137	30·7	4·7		N E.	28·7	7·3		W.	26·3	4·3	0·065	E.	29·3	7·0		S E.	28·0	3·0	?
15	29·944	·103	31·0	8·0		N.	26·7	3·3		(var.)	23·3	4·3		W.	23·3	6·0		N W.	23·0	5·7	S.
☾ 16	30·015	·071	28·7	5·7		E.	23·7	11·0		W.	21·7	12·3		E.	26·7	8·0		S E.	23·0	10·7	?
17	29·599	·416	34·3	5·7	0·469	E.	36·0	12·3	0·462	E.	34·0	12·3	0·660	S E.	33·7	11·0	0·210	E.	36·7	13·7	E.
18	29·502	·203	39·0	4·7		W.	37·7	1·7		(var.)	36·7	2·7		(var.)	37·3	5·0	0·150	S	35·3	3·3	(var.)
19	29·679	·177	39·7	0·7		W.	37·3	1·0		W.	36·0	0·7		W.	33·0	4·3		S W.	34·7	0·7	S W.
20	29·384	·295	36·7	3·0	0·496	E.	35·3	2·0	0·500	E.	33·7	3·0	0·440	(var.)	32·7	3·7	0·280	(var.)	33·7	2·3	W.
21	29·702	·317	31·0	5·7		N W.	25·3	10·0		W.	25·3	8·3		N W.	21·0	11·7		S W.	22·7	11·0	W.
22	29·781	·149	25·3	5·7		N W.	20·0	6·0		W.	30·7	6·0		(var.)	18·3	6·7		S W.	20·0	9·3	N.
23	29·684	·097	23·0	2·3		W.	19·3	2·0		W.	17·3	4·7		(var.)	15·7	6·7		S W.	18·3	8·3	(var.)
● 24	29·802	·127	21·3	1·7		N W.	17·3	2·0		W.	13·7	8·7		N W.	11·3	4·3		W.	13·7	4·7	S W.
25	29·761	·188	25·3	6·7		W.	19·7	8·3		(var.)	19·0	14·7		S E.	30·3	19·0		S W.	30·3	16·7	S W.
26	29·558	·208	39·0	13·7		(var.)	39·7	20·0		E.	37·0	15·0		W.	38·7	15·0		S W.	40·0	13·0	S W.
27	29·972	·414	32·3	8·7		N.	27·7	12·0		(var.)	28·0	9·7		(var.)	26·3	12·8		N.	28·0	12·0	N E.
28	30·077	·106	15·0	17·3	Snow.	N E.	11·0	16·7	0·331	E.	17·0	11·0	0·100	E.	22·0	4·3		E.	22·3	5·7	N E.
29	29·918	·180	11·7	3·3	Snow.	N E.	11·7	1·3		E.	16·0	3·7	0·165	(var.)	25·0	5·0		S E.	20·0	5·7	N E.
30	29·635	·297	27·3	16·7		W.	25·0	18·3		(var.)	23·3	9·3		(var.)	26·3	7·3		S W.	28·7	3·3	W.
31	29·904	·270	20·8	9·7		N W.	14·0	11·0		W.	7·0	18·3		N W.	4·0	22·3		S W.	5·0	23·7	N W.
Means	29·822	·217	31·2	7·0	?	N 21¼ W	28·2	10·0	3·025	S 81° W.	27·1	9·3	3·685	N 43° W.	27·4	11·0	3·644	S 30° W.	27·0	10·2	S. 88° W.

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CIVIL ENGINEERING.

Translated for the Journal of the Franklin Institute.

The Sewerage of Algiers. By M. PIARRON DE MONDESIR, *Ing. des Ponts et Chaussées.*

(Continued from page 155.)

Branch Bab-Azoun.—But the longest and most important work, the construction of the branch Bab-Azoun, remained to be done.

This was commenced in May, 1853. I have said that its length was 4943 ft., and that its basin contained a surface of 279 acres.

The point of departure (Pl. II, Fig. 3,) being established at a height of 52·48, and the point where it meets the sea being 0·00, the mean slope of the branch Bab-Azoun is some 0·01 ft. per foot.* But this branch has the following slopes:

For the first 492 feet,	. . .	·0167 ft. per foot.
" next 3972 "	. . .	·009875 ft. "
" last 459 "	. . .	·005 ft. "

It also has three inclines, amounting in all to 2·78 ft.

There were two reasons for not adopting a uniform slope, which, otherwise, would have been most advantageous. 1st. The street Bab-Azoun has a counter slope at the right of Scipio street, and it became necessary to increase the slope in the first 492 feet, to obtain at the lowest points of the counter slope, a height strictly sufficient for the passage of the sewer. 2d. Between Scipio street and the sea, nothing

* All the heights on the profiles are above the mean level of the Mediterranean at Algiers. It is found from observations that there is a difference of 2·12 ft. between the highest and lowest seas. The mean level is set at 1·06 above the lowest level.

forbade the application of the uniform slope, and it was so adjudged in the project. But, in the course of execution, and with a view to increase the discharge of the branch Bab-Azoun and to suppress the wiers, of which mention will be made hereafter, the Administration substituted two slopes and three inclines. I will soon explain how we arrived at an increase in the delivery of the branch.

Before going farther, I give the sections assigned to the branch Bab-Azoun.

These sections were five in number, with widths successively of 3·9 ft., 4·9 ft., 5·9 ft., 6·2 ft., and 6·56 ft.

The height of the side walls being constant and equal for all sections, the height under the key was successively equal to 5·24 ft., 5·75 ft., 6·23 ft., 6·39 ft., and 6·56 ft.

On calculating afterwards the maximum quantity of water falling in a given time upon the surface of 279·1 acres, forming the basin of the branch Bab-Azoun, (a quantity fixed at ·16 ft. per hour, thus leading a supply to the sewer of 554·4 cubic feet per second,) we had sections nearly double, and consequently a considerable increase in the expense of construction. Instead of increasing the sections, a preference was given in the project to the establishment of wiers, to deliver at the level of the springing line of the arches, by means of existing discharge canals, the eventual waste water of the branch Bab-Azoun, which, without this precaution, might submerge the cast iron tubes placed precisely at that level.

This disposition, approved in principle, could give no inconvenience to the port, which would only be exposed to the accidental reception of water, differing but little from the rain water.

The local administration, still desirous of suppressing these wiers, adopted a modification already made known in the account of the slopes.

It was completed by an enlargement of the lower portion upon the 479 feet corresponding to the reduced slope, ·005 ft. per foot; an enlargement which now has a width of 13·1 feet, instead of 6·56 feet. In all other cases, the widths contemplated in the project have been maintained.

The modification spoken of, thus consisted of the lowering the sewer by means of three inclined planes, whose maximum height was 2·78 feet, and of the enlargement of the lower part, whose slope was of necessity reduced by the use of the inclined planes. The delivery of the branch Bab-Azoun is found to be more than doubled by the simple fact of the enlargement of the lower part. Still, the administration decided to preserve the wiers as a precautionary measure, but giving to them a less overfall than originally contemplated in the project.

Wiers and Discharge.—There are three wiers placed opposite the outlet of the three *ravine sewers* of the rampart Poudriere and Tivoli.

I make use of the term *ravine sewer* to designate that whose lower part only is arched, and the upper part open. Thus, these affluents bringing down in freshets stones, gravel, earth, and other solid bodies, do not enter the sewer of the enclosure except through large gratings. A chamber for the alluvium is placed above the grate.

The peculiar disposition adopted for the ravine of Tivoli penetrates the enclosure sewer through an inclined grate placed at the summit of a cesspit. The alluvium chamber is 6·5 feet deep when it is filled; the ravine water being no longer able to penetrate the sewer, will escape through the development of the ancient sewer of Tivoli, which thus becomes a discharging canal.

Such are the measures adopted to insure at all times the passage of the water of the branch Bab-Azoun.

On examining the longitudinal profile of the branch Bab-Azoun, we observe, that while the sewer descends to the sea with nearly a uniform slope, the level of the streets under which it is situated continues nearly the same.

It follows that starting from Scipio street, the lowest point in the street Bab-Azoun, the depth of the sewer below the surface constantly increases.

Opposite the confluence of the ravine sewer of the Bab-Azoun rampart, at the site of the Theatre, the depth of the excavation exceeds 26 feet.

Thus the sewer was executed under ground from this point to the sea, for a length of 3660 feet.

The branch Bab-Azoun is composed of two distinct parts: the upper constructed in an open cut under the street Bab-Azoun, and the lower part tunneled under the street of the Faubourg Bab-Azoun.

There are five common man-holes in the upper part, and nine well man-holes in the tunneled portion; or, in other words, nine vertical openings which served as shafts for removing the excavation of the tunnel, and were so disposed as to answer for approaches to the sewer. There were twenty-eight water-inlets under the pavements.

The total length of secondary sewers is 2361 feet. The sewer communicates in its course with sixty-five private drains, twenty-three gutters, and seventeen public urinals.

The two portions of the Bab-Azoun branch were worked simultaneously in May, 1853.

The portion with an open cut.—The portion in open cut, following upwards the right hand side of the street Bab-Azoun, was built without serious accidents as far as the end of the arcades. The same precautions were taken, and the same measures adopted, as for the street Bab-el-Oued, and for that of the Marine. None of the houses were damaged, though the excavations attained a depth of 18·7 feet.

Under the site of the Theatre between the extremity of the arcades of the street Bab-Azoun and the man-hole, T 5, were found the ancient *silos*,* which it was found necessary to shore up, and consolidate with special masonry.

Subterranean portion.—The main work consisted in the excavation of the underground part. To expedite the work, they commenced simultaneously sinking twelve shafts, ranged at nearly equal distances along the line. These twelve pits, of which the last two near the sea

* *Silos* are cavities without arches presenting a vertical opening, very narrow. These underground pits served the Arabs for the storage of corn.

have been suppressed and filled up, and of which the nine intermediates between them and the man-hole T 5, have been converted into man-hole pits, were sunk to the level of the principal sewer.

The deepest was the shaft T 15, one of the two suppressed; it had a depth of 69 feet. The miners at the bottom of each pit working in opposite directions, the tunnel was thus worked on twenty-four faces, including that of the sea.

Each gang of miners had as a mean 164 feet of gallery to pierce before a junction with the adjoining one. The excavation was in a schistose rock unfavorably bedded, and much riddled with filtrations.

In the early part of July, 1853, the galleries not being connected, the workmen began to suffer much. The air in the galleries was not renewed, the heat was oppressive, the smell of the lamps and the fume of the blasts having no sufficient outlet, occasioned asphyxia. As the galleries advanced the filtrations increased, and necessitated night and day work. The miners had their feet in water, and at every instant the filtering water fell in cold drops upon their naked and sweating shoulders. With all these troubles there was no stoppage, and the work went on briskly night and day. The position of the workmen was bettered as far as possible by establishing a current of air by means of wind-sails, a simple method borrowed from the navy. Boots were given to the miners to protect their feet, and oil-cloth sacks for guarding against filtrations.

These inconveniences disappeared mostly towards the close of 1853, on successive intercommunication of the galleries being made. Then the filtering water was drained into the sea.

The most important of these filtrations was found in shaft T 10, (Pl. II, Fig. 3,) under the roots of the beautiful palm, which may be se n at the Faubourg Bab-Azoun, at the foot of the Rampe Bugeaud. This fact explains the superb vegetation and excellent preservation of this tree, which without any care prospers in a dry region.

This water became so annoying to the works that it was decided to pierce a gallery 131 feet long, under Faubourg street, and through it turn the water into the sea, and so get rid of it without the expense of drainage. This gallery will be maintained, and will serve for the running of the source of the palm water, which now passes under the flooring of the sewer, in culverts made for that purpose, and will ultimately feed a public fountain upon the new quays. The conjecture held in the project as to the nature of the rock, where it was supposed that a portion of it might answer for revetment, especially for the side walls, proved to be altogether too favorable. In the course of the execution of the project, it was found that we could not dispense with walling the gallery throughout. The thickness of the side walls was fixed at 1·15 ft., and that of the arches 0·82 ft. in one row of bricks. But these dimensions were considerably exceeded in the execution of the work.

To give an idea of the miscalculations and enlargements which attend the execution of certain tunnels, I believe it would be useful to give some details upon this matter.

A careful comparison of the sections of the galleries has been made to ascertain the exact quantity of rock excavated, as well as the excess of the masonry over the proposed thickness of the revetments. The quantity of excavation exceeds by 785 cubic yards the amount answering to the proposed thickness of the revetment, increased by an allowance of 0·196 ft. in all the circumference accorded by the specifications; this answers to an increase of a little over a cubic yard, per running yard, or, say about one-seventh. This increase, independent of that produced by two great land-slides, of which mention will be shortly made, arose from the unfavorable bedding of the rock, from the presence of small layers of clay in their crevices, from the abundance of filtrations, and from the concussion of the miners hammers. The holes and cavities thus formed, had to be replaced by masonry.

Principal Land-slides.—Two great land-slides occurred in the progress of the tunnel, forming funnel-shaped cavities extending from the bottom of the gallery to the natural surface. The first broke out at the corner of a street upon the public square, near the shaft T 9, in consequence of the rain. The funnel was 33 ft. deep, with nearly an equal diameter at the natural surface. A portion of the pavement was precipitated to the bottom, and the neighboring house was endangered. Fortunately none of the laborers were injured. This sudden slide was all the more unexpected, from the fact that well man-hole, T 9, and the neighboring gallery, had, for more than a year, stood perfectly without revetment or indication of the least movement. It was afterwards discovered that the cause of the accident was due to the presence of an ancient well (which had been filled up) lying immediately above the tunnel, but whose bottom did not reach quite to the top of the gallery. This well, whose existence was not suspected, had, by the influence of the rain, burst through at the bottom, carrying with it the neighboring parts. This accident was promptly repaired without any injurious consequences. They were, however, compelled to locate the pit man-hole some yards above in undisturbed soil.

The second land-slide, and the most considerable, occurred near the fort Bab-Azoun, at the 13·12 ft. section. At this point, on the left hand side of the gallery and near the level of the springing line, was met a layer of clay very much inclined towards the fort Bab-Azoun, which passed under the foundations of this work. The rock was not long laid upon this clay, when it began to slide. Land-slides occurred every day, notwithstanding the shoring, and so left large hollows.

Unfortunately this was in the rainy season, and notwithstanding the great exertions made at this point, when only a few days were needed to make this dangerous passage, the hollow broke in from the top. and a large funnel, 39 ft. diameter and 42·5 ft. deep, was formed by .he sliding of the neighboring parts. All the earth above the clay lay r slid, and shattered the streets. The foundations of fort Bab-Azoun were uncovered and were suspended without support for several yards distance. The slide occurred in broad day, but fortunately the workmen, forewarned by certain signals, withdrew, leaving their tools behind them. One only was slightly bruised. There remained a space

from 23 to 26 ft. to be constructed at the bottom of this funnel. The masonry was finished above and below this space.

After filling all the unstable parts, on the demands of the military engineers, the foundations of the fort were strutted with strong beams 39 ft. long. After having propped this part, and placing the workmen under the shelter of a platform resting on the streets, the work of closing this dangerous spot was begun. Fair weather favored the operation, which terminated without mishap.

The works of the branch Bab-Azoun were completed in August, 1855. Commenced in May, 1853, and continued without interruption, the work lasted twenty-seven months. About a year before its completion, the upper portion as far as the ravine Poudriere was finished and put in service. The water was delivered, for the time, through the Poudriere sewer which meets the enclosure sewer at the same level. The lower part, between the Poudriere ravine and the sea, was finished without permitting the entrance of a single affluent sewer. All the connexions were made, but the affluents continued to follow their ancient courses. The removal of some provisional dams sufficed for leading their water into the enclosure sewer. By these precautions, all the lower part of the Bab-Azoun, for a length of 2624 ft., was clear of all impurities up to the time of its completion. In the axis of the bottom there was only running a stream of clear water, proceeding from the filtrations which found their way through outlets made in the side walls.

M. the Marshal Count Raudon, Governor-General, to whom Algiers is chiefly indebted for the benefits of this sewer, took advantage of the occasion to visit the great galleries, before they were put in service. A great number of people were enabled to gratify their curiosity, and to pass through the brilliantly illuminated galleries. This official visit in the interior of a sewer is, probably, the only instance of its kind.

Tram Railroad in the branch Bab-Azoun.—The reduction to 0·005 ft. per foot of slope in the branch Bab-Azoun, in the 479 ft., necessarily had the effect of arresting the alluvium brought down by the water. Thus, notwithstanding the proposed system of flushing, a small tram railroad was established upon a causeway of masonry, occupying the right part of the section of 13·12 ft. Experience has already demonstrated the utility of this railroad, which transports directly to the sea the deposits which otherwise must have been carried by barrows, or taken by manual labor through the man-hole pit, T 14, situated 885 ft. from the lower end. (It will be borne in mind that the two shafts, T 15, and T 16, were suppressed, since they were comprised within the accessory works of the fortifications.) The tram railroad, (Plate I, Fig. 8,) has a length of 482 ft. It is prolonged 69 ft. beyond the outlet so as to admit of the wagons being emptied in the deep sea. The causeway of masonry supporting the railway is 4·27 ft. wide; at the origin the causeway is 1·67 ft. above the axis of the invert, and at the lower end it is 0·62 ft., thus giving to the rail track a slope of 0·0075 ft. per foot. The width of the track is 2·43 ft. Two wagons emptying

at the sides do all that is required. They are suspended from the key of the arch, so as not to be carried away in times of freshets.

Materials used in Construction.—All the masonry used in the enclosure sewer and secondary canals was laid in hydraulic mortar of Italian puzzolano. This mortar, composed of equal parts of excellent fat lime of Algiers, of coarse sand, and of puzzolano of Civita Vecchia, and mixed into a somewhat stiff paste by the shovel and hoe, set quite firmly in from six to eight days.

The upper portion of the invert was covered with spalls and a lining of Vassy cement, presenting, united, a thickness of 0·16 ft. The lower part of the side walls, for a height of 0·65 ft., is lined with this cement, a thickness of 0·065 ft. The remainder of the side walls is coated most carefully with hydraulic mortar. The arches are pointed. Cut stone was used at all the points where the fall of water would injure common masonry. Thus the affluents emptying into the sewer let fall their waters upon cut stone work. The flooring of water inlets, particularly exposed to the shock of rain water, is likewise paved with stone masonry.

Ventilation of the Sewer.—It was essential to spare no pains for the ventilation of the galleries. This is now effected by the water inlet grates, by private drains, by terrace gutters, by the public urinals, and, finally, by the openings of the man-holes. Every canal and every pipe acts as a chimney draft for the gas. The gutters were also disposed so as to produce the best effect.

In speaking of flushing, I will point out another effective mode of ventilation which can easily be applied to the enclosure sewers.

Water Inlets.—On the other hand, the water inlet grates, placed in the axis of the kennels, would, in hot weather, present an inconvenience which we have attempted to remedy.

There are three systems of water inlets used upon the sewer: 1st, the hydraulic system; 2d, the valve system; 3d, the system of grates and movable covers.

The hydraulic system can only succeed with the condition that the reserve liquid stationed in the chamber to cut off the gas should be frequently renewed, and that the chamber should not be constantly choked up with deposit. In Algiers, where the streets are Macadamized, the hydraulic water inlets would soon be choked, especially in winter. On the other hand, in summer there are scarcely any currents of water in the kennels except in the neighborhood of the public fountains. It follows then that the reserve liquid of the chambers would itself give forth an odor quite as offensive as that of the sewer.

Thus, I do not hesitate to say that this system which seems to succeed so well in London and to give so much satisfaction there, is not adapted to the climate of Algiers.

As yet, there has been established upon the enclosure sewer, the branch of the Marine, but a single trap water inlet, as a matter of experiment. (Pl. I, Fig. 10.)

The valve system, which has also been experimented on in the sewer, succeeds far better. The valve allows the water and the deposits to

enter without an escape of the gas. It is essential to give a sharp curve to the bottom of the water inlet. This system is, however, liable to derangement. The rust so quickly produced under such conditions, sooner or later prevents the play of the hinges, and the water inlet becomes completely obstructed.

A third system has been applied to the sewer, which consists in disposing the frame of the water inlet, so as to receive at will either a grate or a cast iron cover with a hole in its centre. In winter, when it rains frequently and the inconvenience of the gas is much diminished, the movable grates are placed; but in summer they use the covers. The hole suffices for the flowage of the kennels. If by chance a sudden rain storm should occur in summer (a quite unusual thing in Algiers), the gutter-men in charge could readily raise the covers until the end of the storm.

The system of grates and movable covers which is generally applied to the enclosure sewer, had already existed for several years upon the other sewers of Algiers. They are attended with some inconvenience, but the sum of the advantages unquestionably outweighs it.

Private sewers.—For the junction with private sewers certain precautions were indispensable. It was first necessary that the government should compel the proprietors whose canals already branched into the ancient sewers emptying into the harbor, to make new branches into the enclosure sewer or its affluents. For this purpose, a decree was made by the Mayor of Algiers, dated 12th October, 1852, whose purport was:

ART. 1. According with the advancement of the sewer works of Algiers, the proprietors or principal local tenants of the houses situated in the streets Bab-Azoun, Faubourg Bab-el-Oued, Marine, at the Government square, Mahon, and other streets or squares adjoining, whose conduits empty directly in the harbor, or into sewers which are to be modified or suppressed, shall execute in the interior of their houses, and according to the indications to be given them by the engineer in charge of the sewerage, all the necessary changes for uniting their conduits with the enclosure sewer or its affluents.

ART. 2. The connexion shall be made in the man-holes, which shall be constructed by the Government in the limits of the public street, at the points indicated by the proprietors themselves, who shall cause their conduits to empty in the man-holes, at the level assigned by the government, in establishing at their expense the grate prescribed by the order of May 17, 1847.*

I would here state that the proprietors without exception cheerfully complied with the execution of this order, and that some have had important works in bringing them down to the level of the sewer.

As for all the connexions made under the public street at the present time, two cases are presented, according as the depth of the invert of the private sewer is either above or below 5·25 ft.

In the first case, there is established under the arcades or pavements a man-hole into which empties the private sewer across the required grate. This grate is movable, and is retained in its place by a cross-piece with two screw rings inserted. The man-hole is closed by a cut-stone cover with an opening in it. The grate arrests the solids. If

* The decree of May, 1847, fixes the conditions on which the junction of the private conduits with the public sewers shall be made, and prescribes, among other matters, the placing of a grate with bars ·06 ft. interval. This grate is designed to prevent the introduction of solid matters into the public sewer.

Fig. 3.

Fig. 4.

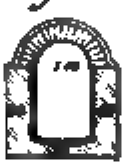


Fig. 5.

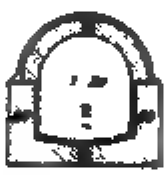


Fig. 6.

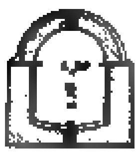


Fig. 7.

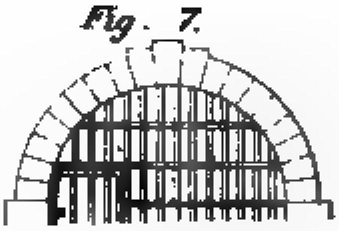
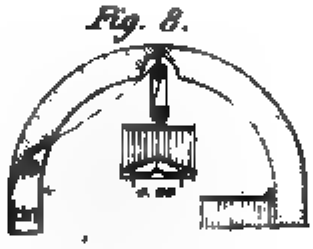
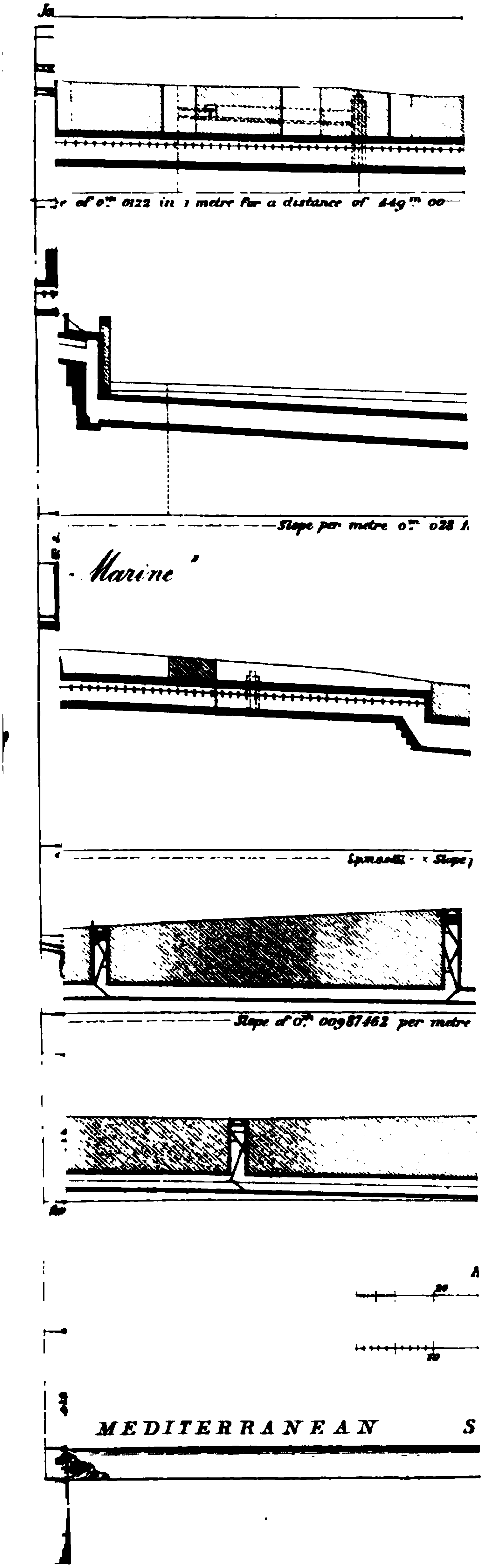


Fig. 8.

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Slope per metre 0.m 028
Marine
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10
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the private conduit is choked up above the grate, it is cleansed with the greatest ease by opening the man-hole, and taking down the grate. The second case not admitting of cleansing in the man-hole, the latter is discarded, and the grate is placed in the enclosure sewer in the plane of the side walls.

We might undoubtedly have profited by the establishment under the arcades of a hydraulic chamber, and by this means have intercepted the gaseous currents, ascending from the main sewer to the house, and so put in practice the system generally followed in London for the private sewers. But it must be borne in mind that the houses of Algiers are not in the same condition with those of London. The latter enjoy the advantage of a distribution of water in every house, and can thus renew at will the reserve liquid of the hydraulic chamber; while our houses in Algiers are deprived of this means of cleansing, without which the hydraulic basin cannot well be maintained.

In the actual condition of the houses of Algiers, the hydraulic basin applied to private sewers, would be attended with inconveniences for the water inlet which I have already spoken of. The administration as yet have made no application of them in the man-holes under the arcades. As for individuals who are at perfect liberty to apply them in the interior of their houses, they do not find their local conditions to be such as to warrant the establishment of the system. In fact, the underground cellar found in all the houses of London, and which is so admirably adapted to the establishment and maintenance of hydraulic basins, does not exist in the houses of Algiers.

The private drain, in place of being found, as in London, immediately under the flagging of the cellar, sometimes crosses under the vestibule, sometimes under a store-house, sometimes under an underground piece, at a variable depth. We may conceive then, that these local dispositions are an obstacle in the establishment of hydraulic basins.

It may not be amiss to remark in passing, that the houses of London have a greater interest at stake in guarding against the exhalations of the public sewers, whose gas is driven back by the flood tide, than those of Algiers, which are naturally protected against this evil.

Simple Man-holes.—The simple man-holes established along the main sewer, are arranged so as to permit the introduction of cast iron tubes, ultimately to be placed upon the consols now awaiting them. They are all after the same model. Cut-stone bond is bedded in the arch of the sewer. The upper face is laid at a level of 1·18 ft. above the intrados of the key, and the lower face is cut conformably with the curve of the arch. The interior opening has the form of a vertical cylinder whose base formed of semicircles joined by a rectangle, has a length of 3·28 ft. in a parallel, and 1·96 ft. in a perpendicular direction to the sewer. This serves as the base of a conical chimney terminated above by a circular opening 1·96 ft. in diameter. The upper part of the man-hole is closed by a cut-stone frame supporting a tarred oak frame, under which re-

pose the cast iron frame and cover.* This disposition, as we have before observed, has also been applied to the water inlets. Openings made in the conical chimney allow the workmen to descend into the sewer. The cut stone bond bedded in the arch is slightly rounded to facilitate the introduction of the cast iron pipes.

(To be Continued.)

Steam Engineering in 1859.† *The Mechanism of the Steam Engine.*

In all the machinery there are two distinctive classes of defects in construction. There are those which are so palpable as to bring discredit to the designer; and there are those, which, although in certain existence, may pass unnoticed and uncared for, during the life of a machine.

In the first class may be included, want of strength, bad materials, bad workmanship, and deficient knowledge in the expanding and contracting powers of materials; in the second class, we find chiefly, want of adaptation, complication, want of simplicity, errors of principle, and needless difficulties of access for examinations, repairs, and renewals.

We propose to say a few words on each of these classes of defects in steam machinery.

The engineering profession is indebted to the experiments of such eminent men as Fairbairn, Barlow, and others, for a practical knowledge of the strength of those materials used in the construction of a steam engine, and this knowledge is so easily accessible, that ignorance is inexcusable.

Constructive proficiency is obtainable in two ways: by experience, and by a careful study of the properties of materials. Many engineers depend almost wholly upon the former, few trust entirely to the latter; it is only when the two are combined, it deserves the title of engineering.

In old-established firms, where the same class of machine has been constructed for forty or fifty years, a degree of perfection is attained, difficult to be found in new establishments, although the manager may be most competent. There are exceptions to this general statement, and we might, perhaps, instance as one, the hydraulic machinery of Sir W. Armstrong, where there has been almost undisturbed success, and comparatively no failures with a new establishment, and a new class of machinery. We believe we can trace the cause of this success, but we do not feel at liberty to allude to the management in detail of any private establishment.

One strange anomaly in the manufacture of steam engines is the abominable specimens often found driving the tools of the firms who advertise to supply steam engines on the most improved principles. This is more the case in the North and Wales than in the South. You enter a large fitting shop, and hear in one corner, a wheezing, grinding

* This system was brought into use for the first time at Paris by M. Emmery, Engineer-in-Chief. (See his Memoir upon Sewers and Fountains.—*Annales des Ponts et Chaussees*, 1834, *Tome* x.)

† From the Lond. Artisan, Oct., 1859.

noise, which, upon examination, proves to be a "Pre-Adamite" steam engine, dirty, leaky, and most extravagant in fuel.

How is it that, with such an extended experience, amounting to nearly 100 years, we have yet, at the present time, frequent breakdowns and mishaps with our steam machinery? Surely, as such admirers of "precedents," we ought to be exempt from the mishaps of our Transatlantic friends, who do not hesitate to throw "precedent" overboard.

We believe the chief cause of our failures is the exclusive spirit existing among our manufacturing engineers, and although this exclusiveness tends to develop in competition, individual excellence and talent, it undoubtedly fosters positive ignorance and contempt for the improvement of others.

We could positively fill pages with particulars of constructive failures, not of small people, but of engineers, employing from 400 to 800 men, and we refer chiefly in these remarks, to marine engineers.

With land and locomotive engines, there are frequent opportunities for the manufacturer to observe defects in daily regular work, but in marine engines, it frequently happens the designer has had little or no experience at sea, and, unlike the Cornish man, he is too proud to "ax what he do'ant know." Hence it is, we find patentees abounding, who profess to supply us with engines so compact that they remind one mostly of those turned Chinese balls, one inside the other; but how they were put together, or how they can be separated, are questions difficult to solve.

It has been our misfortune, or, more correctly, *good* fortune, to be at sea in very bad weather, with new machinery, and we, therefore, can speak with certainty of the inconveniences—not to mention danger—of defective construction; too much or too little taper in cocks, soft brasses, slack nuts, inaccessible valves, accessible passages for dirt or coal, and imperfect joints, &c.

Beam engines for land or sea have had their day; they have been most efficient, and possess advantages not to be denied; but with the necessity for less weight, fewness of parts, and increased speed, they cannot compete with the oscillating, trunk, and other direct-acting engines.

For land purposes the horizontal engine, with long stroke and connecting rod, will multiply, on account of its small cost and simplicity.

For steam navigation, simplicity is a great desideratum, perhaps we might say as to mechanical construction, it is *the* great desideratum. Compactness is all very well, if it means not an unnecessary waste of room, but compared with efficiency or economy, it is not to be considered. A ton of coal saved, will give 40 cubic feet additional space for machinery, and it will be found that space is economized, not by extreme compactness, which generally induces neglect in maintenance, but by efficiency and economy of fuel; and it is highly satisfactory to know that, in adopting economical principles of construction, the economy attained is not confined to a mere saving of fuel, but of space, and we believe of capital also.

If it is possible to obtain 100 per cent. more power from one ton of coal, there is every reason to believe such increased power can be secured without a corresponding increase in the first cost of the machinery.

These remarks bring us to a subject we wish to impress upon our readers, namely, the dimensions of cylinder and speed of piston.

A large cylinder and a short stroke are synonymous with waste of fuel, and yet large cylinders and short strokes prevail; indeed, in many cases the stroke does not exceed half the diameter of the cylinder. That such engines can realize the benefits to be derived from expansive action is almost impossible, whilst the amount of surface exposed for premature condensation is nearly a maximum.

We are quite alive to the importance of direct-acting screw-engines, running at a high speed, to insure a minimum amount of slip, and the length of stroke is regulated by what is considered a safe speed of piston; and there is reason to fear all efforts to decrease the diameter, and increase the length of steam cylinders, must be very limited, as long as the steam pressure is only 20 or 25 lbs. per inch, and the air-pumps attached to the main engines. With higher pressure the diameter can be reduced, and with separate air-pump engines the number of revolutions and speed of piston can be safely increased.

To insure lightness in engine power, a maximum speed of piston is indispensable, and it may be taken for granted, that from 350 to 500 feet per minute, will be generally adopted for marine engines in a few years. If the speed of an engine is increased 50 per cent., the mean pressure remaining the same, an increase of 50 per cent. of power is thus obtained without any additional outlay of capital, except what is required to give the increased quantity of steam, and it is well known the cost of boilers is only about one-third of that of the engines to which they are attached.

Increased pressure, and increased speed of piston, we reiterate, are among the chief mainstays of future progress in steam power on land and sea.

As a natural consequence of an increased speed of piston, spur wheels, loose cranks, beams, levers, and all needless complications, must be dispensed with, steam must be applied direct to the resistance, and instead of *one* vast unwieldy machine, we must increase the number and decrease the size.

Mechanical lubrication is not sufficiently attended to in fast moving engines; by self-acting lubrication, heating is avoided, and oil saved, and yet, in our mercantile steam navy, how few screw engines are fitted with self-acting lubricators.

Land engines are hardly considered complete without governors for regulating their speed; whilst marine engines, with an ever varying load in a sea way, are only preserved from actual break-downs, by the constant attention of the engineer in charge—room again for improvement.

With reference to the *evils* of what is called a *compact* engine, we remember a case in which a pair of engines were put on board a ship,

so compact, that after running a short time, they were removed, simply because no engineer could be found, willing to risk his arms and fingers in keeping them in order; and, in a less degree, this is a state of things not at all uncommon at the present day.

There are various details worthy of attention and capable of great improvement, such as increased wearing surfaces, and the position of thrust-bearing, the latter too often forming a portion of engine framing, so as to throw crank pins, connecting rods, &c., out of truth, as the thrust-bearing wears.

And what shall we say about screw propellers? Who knows anything definite about them, except captains and masters of steam ships? They are the gentlemen to explain, with the greatest clearness, the precise action of the screw; the only misfortune is, that no two of these gentlemen agree.

We are inclined to the opinion that, if the present amount of experience in the diameter, pitch, and shape, of screw propellers was appreciated and applied, we could greatly increase their present duty.

One fact is proved beyond all doubt, that it is not advisable to have the pitch of a propeller more than 50 per cent. in excess of the diameter. The principles of construction included in what is called Griffiths' screw, are undoubtedly nearer the truth than any other; and there is a general tendency among engineers to adopt those principles, as far as they can, without actually infringing Mr. Griffiths' patents; but still the bulk of our marine engineers adhere to precedent too firmly, to profit by the general experience, and we have in existence a collection of propellers, only suitable for a museum of antiquities.

Supposing we have a good pair of engines, how do we place them in the ship? in a clean space by themselves—oh, no! *in the stoke-hole.* Yes, hundreds of screw engines, from 70 to 200 H. P., are working in the stoke-hole, placed there, we presume, to receive all the dust and dirt, to act as emery powder on the bearings, and to prevent the possibility of the engineers in charge, keeping the machinery clean—*another advantage* (?) of this arrangement, is the passage of cold air from the engine-skylight over and round the cylinders (in inverted engines) before it reaches the ash-pits and stoke-hole.

On land, generally, the engine is placed by itself, as it ought to be, but at sea, where repairs are more difficult and costly, grit and dirt are positively encouraged.

It rests with engineers themselves whether they are to have sufficient room on board ship, to place their engines so as to insure easy access for repairs, and perfect separation from the stoke-hole. Steamship owners oppose their own interests, by refusing proper space for machinery, and lose in economy and efficiency to an unknown extent.

We purposely avoid expressing any opinion on the several varieties of direct-acting engines now in use, each has its advantages and disadvantages, but there can be no doubt, a preference should be shown to a long stroke and a long connecting rod. Trunk engines are compact, but they expose a large surface for premature condensation. Oscillating engines are objectionable in many instances, on account of

the difficulty of obtaining a simple and effective expansion gear; but faults of detail in the mechanism, sink into comparative unimportance, in comparison with the faults we have alluded to in the "generation of steam" and its "application as a motive power."

Much latitude may be allowed in the position and disposition of cylinders, rods, levers, &c., but *no* latitude can be allowed in the application of correct principles of economy, in the construction of steam machinery; it is in this latter respect we are so very remiss, and whilst we have one hundred plans for some trifling and almost unimportant alteration of mechanism detail, we are sadly wanting in practical suggestions for solid improvement and permanent economy.

In concluding these very brief remarks on the mechanism of the steam engine, it is not consistent with the design of these papers to enlarge on mechanical details, nor to refer to questions quite separate from the economy of steam power, our chief aim being to draw attention to prominent defects, and especially those that increase, needlessly, the maintaining and working cost of steam power.

Who knows, with any certainty, the effective duty of different classes of steam engines, as compared with their indicated or total power? the power absorbed in friction may amount to 30, 40, 50, or 60 per cent., according to the perfection of the workmanship and arrangement of the parts of a steam engine, and yet how seldom is a dynamometer applied. On land, of late years, dynamometers have been much introduced, even for engines of only 10 to 20 H. P., but in marine engines, of 100 to 500 H.P., it might be supposed frictional knowledge and experience is of little importance, whether 100 or 200 H. P. is required to overcome friction, is not considered of sufficient importance to justify an outlay of £50 in a dynamometer.

In our next paper, we shall endeavor to give a resumé of all the chief points alluded to in this and the five preceding papers.

(To be Continued.)

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*Great Spans in Railway Bridges.**

The widest single span of any railway bridge in the world, is that of the Niagara Suspension-bridge, connecting the American and Canadian Railways, at Niagara Falls. The clear span is 822 feet. A still wider single span—one of 1224 feet—is being constructed for carrying the Lexington and Danville Railway at an elevation of 300 feet over the Kentucky river, in the United States. The next widest spans are those of the Britannia-bridge, 460 feet each. Then come the two great spans of the Saltash bridge, of 455 feet each. The next great railway span is that of the Conway bridge, of 400 feet. The next is the immense bridge carrying the Royal Eastern Prussian Railway over the Vistula, at Dirschau. This is an iron lattice bridge, having six spans of 397 feet 3 inches each. The Nogat Bridge, on the same line, has two iron lattice spans of 321 feet, and one span of 53 feet 6 inches. The great railway bridge recently opened at Cologne, has four lattice spans of 344 feet 6 inches each. The openings of the railway bridge of Kehl will be nearly as wide. The middle opening of

* From Herapath's Railway Journal, No. 1075.

the great Victoria-bridge at Montreal, is 330 feet wide, the other 24 openings being each 242 feet. The Chepstow bridge has a span of 306 feet, besides three spans of 100 feet each. The Boyne Viaduct has one lattice span of a clear width of 264 feet, and two side spans of 138 feet 8 inches each. The Newark Dyke-bridge, the largest example of Warren's trussed girders, has a span of 240 feet 6 inches. Several of the tubular bridges erected by E. Gouin & Co., of Paris, over the Garonne, the Lot, the Tarn, &c., have spans of 80 metres, or 262 feet. The Spey Viaduct, on the Inverness and Aberdeen Junction Railway, consists of a pair of box girders of a clear span of 230 feet. The tubular bridge at Brotherton has a span of 225 feet. The greatest timber span in a railway bridge, and now indeed the widest timber span in existence, is one of 275 feet, that of the Cascade bridge, on the New York and Erie Railway in the United States. The Market street (highway) bridge, formerly crossing the Schuylkill at Philadelphia, U. S., had a timber span of 340 feet; whilst a timber span of 390 feet, the widest ever attempted in that material, was constructed by John Grubenmann over the Limmat, in Germany, in 1794, and was burnt shortly afterwards by the French troops. Railway bridges with timber spans of 250 feet, are not uncommon in the United States. The great railway bridge across the Mississippi river, at Rock Island, has five timber spans of 250 feet each, besides three others of 150 feet. The bridge by which the Ohio and Mississippi Railway crosses the Great Miami river, has five timber spans of 250 feet each; and another railway bridge, having two timber spans of 260 feet each, crosses the Delaware river near Port Jervis, State of New York. The widest masonry span ever erected for railway purposes is one of 180 feet, carrying the Glasgow and South Western Railway over the river Ayr. The new railway bridge being carried across the Thames at Pimlico, will have four cast iron arches of 175 feet each, the widest cast iron spans, we believe, yet employed for railway purposes. The six spans of the celebrated High Level bridge at Newcastle, are but 125 feet each in width.—*The Engineer.*

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*A Building Coated with Water-glass.**

A friend who is in Paris has made for us a particular examination of the public buildings—the Palace of the Louvre and the Cathedral of Notre Dame—which have been coated with Prof. Kuhlmann's water-glass. The result, we grieve to say, is not very favorable. The theory is apparently right, yet the method of practically applying the silicate has yet to be sought by the French chemist. Rain, even in dry Paris, has been beforehand with the preparation. Before the silicate could absorb a sufficient quantity of carbonic acid, the moisture has got into it, and wholly destroyed its preservative powers. The experiment, we hear, is thus far pronounced a failure. Yet science is clearly on the track of discovery, and ere long it will probably conquer all the difficulties now standing in the way of a general use of the conservative powers of water-glass.

* From the Lond. Athenæum, Aug., 1859.

The following TABLE gives a comparison of the number of passengers, tons of goods and minerals, and heads of live stock carried in the years 1856, 1857, and 1858:

		Passengers.					General merchandise.	Minerals.	Number of Live Stock.			
		First class.	Second class.	Third class and parliamentary.	Holders of periodical tickets.	Total.	Tons.	Tons.	Cattle.	Sheep.	Pigs.	Total.
England,	1856	14,418,760	35,490,844	58,438,432	20,865	108,368,901	20,224,829	33,309,666	1,487,961	71,815 5,400,305	1,048,981	8,009,062
	1857	15,671,096	36,603,060	63,562,252	22,398	115,858,806	21,138,732	37,639,303	1,778,259	4,432 5,693,092	1,112,346	8,588,129
	1858	15,162,796	36,199,373	64,568,572	26,216	115,956,957	21,687,649	38,298,709	1,770,846	15,922 5,537,130	1,371,398	8,695,296
Scotland,	1856	1,664,005	1,952,240	9,476,226	4,767	13,097,238	2,683,184	7,527,843	300,600	980,748	48,923	1,330,271
	1857	1,823,542	2,180,284	10,723,694	5,983	14,733,503	2,909,139	8,527,893	331,443	1,042,568	37,973	1,411,984
	1858	1,963,821	2,150,334	10,647,854	6,959	14,788,968	2,895,916	9,040,903	316,458	1,062,638	47,496	1,426,592
Ireland,	1856	1,034,713	3,223,077	3,616,899	6,764	7,881,453	915,917	101,166	209,187	462,550	439,555	1,111,292
	1857	1,112,188	3,382,941	3,912,183	9,267	8,416,579	980,056	126,788	255,027	349,113	442,907	1,047,047
	1858	1,155,767	3,343,582	3,929,038	19,387	8,447,774	1,071,055	130,064	236,001	338,392	629,725	1,204,118
Great Britain and Ireland,	1856	17,117,477	40,666,162	71,531,557	32,396	129,347,592	23,823,930	40,938,675	1,997,748	71,815 6,843,603	1,537,459	10,450,625
	1857	18,606,826	42,166,285	78,198,129	37,648	139,008,888	25,027,927	46,293,984	2,364,729	4,432 7,084,773	1,593,226	11,047,160
	1858	18,302,384	41,693,289	79,145,464	52,562	139,193,699	25,654,620	47,469,676	2,323,305	15,922 6,938,160	2,048,619	11,326,006

And the following Table gives a comparison of the receipts for the same three years:—

		Passenger Receipts.										
		First class.	Second class.	Third class and parliamentary.	Miscellaneous, including luggage, parcels, carriages, horses, dogs, and mails.	Total.	General merchandise.	Minerals.	Live Stock.	Total receipts from all sources of traffic.	Total working expenses calculated upon the average amount by those Companies who have supplied statements.	Proportion per cent. of working expenses to receipts.
		£	£	£	£	£	£	£	£	£	£	
England,	1856	2,601,353	3,025,076	2,834,241	1,189,991	9,650,651	6,665,135	3,001,841	410,675	19,728,312	9,361,746	49
	1857	2,753,123	3,147,398	2,921,158	1,253,876	10,075,555	6,728,668	3,313,256	410,268	20,527,747	9,827,640	48
	1858	2,582,163	3,104,726	2,905,439	1,291,142	9,833,470	6,637,585	3,335,122	387,918	20,241,095	10,152,269	50
Scotland,	1856	232,130	171,588	436,564	121,525	961,807	739,426	570,677	47,307	2,319,217	1,090,031	47
	1857	251,184	178,778	471,432	127,282	1,028,676	767,297	657,592	47,913	2,501,478	1,100,650	44
	1858	250,203	174,885	472,598	134,114	1,031,800	765,403	692,893	46,837	2,536,933	1,116,250	44
Ireland,	1856	158,678	242,317	241,423	121,452	763,807	280,818	13,473	59,804	1,117,965	436,006	39
	1857	163,161	248,812	244,628	127,385	783,987	285,778	16,413	59,177	1,145,385	431,246	38
	1858	170,472	247,766	238,156	126,241	782,634	308,398	18,046	66,643	1,175,721	470,288	40
Great Britain and Ireland,	1856	2,992,161	3,438,981	3,512,228	1,432,968	11,376,338	7,685,379	3,585,991	517,786	23,165,404	10,887,783	47
	1857	3,167,468	3,574,988	3,637,218	1,508,544	11,888,218	7,781,743	3,987,201	517,358	24,174,610	11,362,536	47
	1858	3,002,836	3,527,877	3,616,192	1,551,497	11,697,904	7,711,386	4,016,061	501,398	23,956,749	11,738,807	49

The number of persons who suffered from accidents on railways in the years 1857 and 1858, compared with the number of persons who traveled, is exhibited in the following Table:—

DESCRIPTION OF PERSONS.	1857.								1858.							
	England.		Scotland.		Ireland.		Total on all railways in 1857.		England.		Scotland.		Ireland.		Total on all railways in 1858.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Passengers killed or injured from causes beyond their own control,	24	606	1	25			25	631	25	386	1	23		10	26	419
Passengers killed or injured owing to their own misconduct or want of caution,	18	11	2	3	3	1	23	5	21	13	2	1	2	4	23	18
Total number of passengers killed or injured,	42	617	3	28	3	1	48	646	46	399	3	24	2	14	51	437
Servants of Company or of contractors killed or injured from causes beyond their own control,	14	28	1	9	3	2	18	39	10	47	6	1	1	4	17	52
Servants of Company or of contractors killed or injured owing to their own misconduct or want of caution,	59	28	7	3	9	3	75	34	71	31	30	11	13	7	114	49
Other persons crossing at level crossings,	28	5			2		25	5	17	4	1		3	1	21	5
Trespassers,	40	13	11	1	3		54	14	46	8	10	1	6	2	62	11
Suicide,	6						6		4		1				5	
Miscellaneous,	6		2		2		10		5			1	1	1	6	2
Total,	190	691	24	41	22	6	236	738	199	489	51	38	26	29	276	556
Total number of passengers conveyed,	115,858,806		14,733,503		8,416,579		139,008,888		115,956,957		14,788,968		8,447,774		139.193,699	

The following Table shows the proportion of passengers killed and injured from causes beyond their own control, per million, conveyed in the several years, from 1852 to 1858 inclusive:

	England.		Scotland.		Ireland.		Great Britain and Ireland.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1852	·14	4·30	·00	5·80	0·00	8·20	·11	4·20
1853	·23	2·60	·09	4·50	2·40	1·60	·35	2·80
1854	·09	3·08	·16	3·51	0·14	0·57	·10	2·97
1855	·08	2·51	·08	4·50	0·14	0·97	·08	2·70
1856	·07	2·35	·00	1·92	0·00	0·25	·07	2·18
1857	·20	5·23	·06	1·69	0·00	0·00	·18	4·53
1858	·18	3·31	·07	1·55	0·00	1·18	·19	3·01

MECHANICS, PHYSICS, AND CHEMISTRY.

Aerometry. Translated from the Hydraulics of D'Aubuisson de Voisins. By J. Bennett.

(Continued from page 192.)

CHAPTER SECOND.—*Blowing Machines.*

The name of *blowing machines* is given to the great bellows employed in the arts to produce a continuous blast, either for animating the fires of forges and other metallurgic works, or as ventilators.

Formerly these machines were but bellows of the common form, lined with leather, or rather double wooden boxes; the one was fixed, the other was movable; the lining consisted also of wooden strips.

Now, they are formed of great cylindrical or prismatic pump bodies of cast iron, or of wood, or marble, in which moves a piston lined with leather or wooden strips; it has two valves, the one for the inlet, the other for the outlet of the air; they are single or double acting.*

In some places they use *hydraulic blowers* where the water plays the part of the piston, but of an immovable piston, and the pump barrel alone moves; sometimes it consists of a great vessel, a kind of gasometer, ascending and descending in a basin filled with water; sometimes of casks half filled with water furnished with suitable partitions and valves, which turn upon their axes.†

In mountainous countries, having great water-falls, they make frequent use of "*trombes*;" these are shafts, or vertical and hollow cylinders slightly contracted just below the upper end, in which falls a current of water carrying with it the air which continually enters through the small openings or *exhausters* pierced below the contraction. This air enters the box in which the shafts abut, and depart through a tube placed for that purpose.

Mention was made, in No. 471, of the Archimedes Screw being used as a blowing machine. I am not familiar with them. It is said that one is used successfully at a blast furnace for smelting iron, at the works of M. Koechlin, near Mulhouse.

These different machines deliver a current of air at a given point through the intervention of *wind-trunks* or long conduits. Sometimes the pipes are fitted immediately to them; but more frequently, and when it is proposed to maintain a continuous blast, two, three, or four, pump barrels discharge their air into a common reservoir whence depart the conduits which lead it to its destination.

Effect of Blowing Machines.—The dynamic force imparted to this air, that it may enter, pass through, and issue, from the pipes with a given quantity and velocity, will represent the effect of the machine considered only as a blower, all other resistances being disregarded. The useful effect will consist solely of the action required to drive

* A description of these machines may be found in the *Richesse* Minérale of M. Heron de Villefosse, Tome iii; and in metallurgic treatises, especially in the *Manuel de la Metallurgie du fer*, by M. Karsten, Tome ii of the French translation of 1830.

† See description of one of these machines which I published in Tome ix of *Annales des Mines*, 1821.

through the orifice at the end of the pipe, this quantity of air with this velocity.

533. *Useful Effect.*—The useful effect of a machine is generally estimated by the weight of the body moved, multiplied by the height due to the velocity of the motion. Moreover, when any fluid issues from a vessel under a certain pressure, the velocity of efflux has, for the height due, the height of a column of the issuing fluid whose weight equals the pressure (14). According to these two principles, *the useful effect of a blowing machine will be expressed by the weight of the air emitted in* 1 *sec., and by the height due the velocity of emission.*

I give a direct demonstration of this fundamental theorem. Let us take for the machine, a cylinder with a piston, to which is fitted an efflux ajutage. Designate by Σ the surface of the piston, by v its ascensional velocity, by H the height of the mercury manometer placed upon the upper base of the cylinder, by Δ the specific weight of the mercury, by σ the section of the outlet orifice, corrected for the effect of contraction, by Υ the velocity of the air's efflux, by δ the specific weight of this fluid, and, lastly, by ρ the absolute weight of that issuing in one second. We have, manifestly, $\rho = \sigma \Upsilon \delta$. Since the flowage is permanent during the raising of the piston, (excepting the first instant,) the velocities will be in the inverse ratio of the sections, and we shall have $\Sigma v = \sigma \Upsilon$

$$\text{and consequently } \rho = \Sigma v \delta, \text{ or } v = \frac{\rho}{\Sigma \delta}$$

Moreover, the effort made by the piston to compress the air above it so as to give it the elastic force H, in virtue of which, it issues with the velocity Υ; this effort, I say, is evidently equal to that required for raising a layer of mercury spread upon the piston, whose thickness is H; now, this effort is manifestly represented by the weight of this layer, which is $\Sigma \text{H} \Delta$. The effect of a machine consisting of the weight raised, multiplied by the height of the elevation in 1 sec., a height which here is v, that of the blowing

$$\text{cylinder will be} \qquad \Sigma \text{H} \Delta v = \Sigma \text{H} \Delta \frac{\rho}{\Sigma \delta} = \rho \text{H} \frac{\Delta}{\delta}$$

an expression in which the first factor is the weight of the air emitted, and the second is the weight due the velocity of emission. (500.)

This height is also equal to $\frac{\Upsilon^2}{2g}$; the mass M of air whose weight is ρ, being $\frac{\rho}{g}$, we shall also have, for the expression of the effect, $\frac{1}{2}\text{M}\Upsilon^2$; that is to say, the effect of a blowing machine, is one-half of the vis viva of the issuing air.

534. When the ajutage is immediately attached to the machine, the weight of the air issuing in 1 sec., is (510)

$$30{\cdot}787\sqrt{\frac{b+\text{H}}{\text{T}}}\, d^2\sqrt{\text{H}}$$

and the height due to the velocity of issue, equals (500)

$$26103{\cdot}8\ \frac{\text{T}}{b+\text{H}}\,\text{H};$$

thus the useful effect will be

$$803660\sqrt{\frac{\text{T}}{b+\text{H}}}\, d^2\,\text{H}\sqrt{\text{H}}.$$

535. If the air, instead of issuing immediately from the reservoir through an ajutage fitted to it, should have to pass through a long

pipe, at the end of which is fitted the outlet orifice; where the manometer has the height h, the useful effect will be

$$803660 \sqrt{\frac{T}{b+h}}\, d^2\, h \sqrt{h}$$

As in applications of these formulæ to practice, we can only arrive at approximations, we may substitute for T and $b+h$ the mean values already indicated (511) and we shall have the useful effect of a blowing machine; h being the height of the manometer placed at the end of the conduit.

536. *Total Effect.*—Whatever may be the conduit, so long as h preserves the same value, the weight of air issuing in 1 sec. still remains $48{\cdot}073\, d^2 \sqrt{h}$ (511), and the effort exerted at the end of the conduit to drive out the air is always represented by h; but, at the entrance of the pipe, where the machine acts, there is exerted an effort, H, which is h increased by the resistance H—h, experienced by the air in the tubes; so that the quantity of action impressed, or the dynamic effect, is the above expression increased in the ratio of H to h, and, consequently, $514300\, d^2\, H \sqrt{h}$.

537. It is seldom that the heights H and h are found, as quantities given or sought, in questions offered for solution, and it is proper that they should be eliminated from the expression of the effect. We, therefore, take for H its value deduced from the relation given in No. 523, and we have for the effect,

$$514300\, d^2 h^{\frac{3}{2}} \left(1 + 0{\cdot}0238 \frac{L d^4}{D^5}\right).$$

Then we put for $h^{\frac{3}{2}}$ its value derived from the equation

$$\rho = 48{\cdot}073\, d^2 \sqrt{h} \quad (511),$$

where ρ is the weight of the air discharged in 1 sec., and we have, all reductions being made,

$$0{\cdot}11017\, \rho^3 \left(\frac{L}{D^5} + \frac{42}{d^4}\right).$$

Most frequently the quantity of air issuing from a blowing machine is expressed in volume and not in weight. Substituting, then, Q for ρ, and remembering that, under the pressure 2·493 ft. and at the temperature 53·6°; $\rho = 0{\cdot}0325 \frac{2{\cdot}4934}{1{\cdot}048}$ Q, we shall have

$$\cdot 0000509\, Q^3 \left(\frac{L}{D^5} + \frac{42}{d^4}\right) \text{ lbs. ft.}$$

538. Such is the force to be imparted to the air to drive it in the conduit; but that to be impressed upon the machine, upon the piston which drives the air, for example, is considerably more, for it has to overcome the friction of the piston against the sides of the cylinder, &c. Moreover, as in pumps, (431), there is a *prejudicial space* seated be-

tween the piston at the highest point of its stroke and the upper base of the cylinder, the air which fills this space alternately contracts and dilates at each oscillation of the piston, and without escaping; whence we have a new employment for the motive action. Still further a notable portion of the air inhaled, a quarter, a third, and frequently more, escapes through the lining of the piston, or through the imperfect joints; though this may be without a useful effect, there is, nevertheless, required a force to drive it up to the points of escape; so that the total force to be imparted, or the effect E, will exceed the above expression; we therefore give it a suitable increase in multiplying by n, and we have $\text{E}=\cdot0000509\, n\, \text{Q}^3 \left(\frac{\text{L}}{\text{D}^5}+\frac{42}{d^4}\right)$.

539. *Fundamental Equations.*—Here, as for all machines, (289,) we have $\text{E}=n p h$, p and h being the weight and the fall of the motive water. Making $\frac{n^1}{n}=m$, the equation for resolving the different questions relating to blowing machines will be

$$m\, p\, h=\cdot0000509\, \text{Q}^3 \left(\frac{\text{L}}{\text{D}^5}+\frac{42}{d^4}\right).$$

The co-efficient m referred to the useful effect, will vary with the machine used, and will have values which we proceed to indicate.

540. In blowing machines, as in hydraulic wheels, m, or the ratio between the effect produced and the motor-force employed to produce it, varies with the different kinds of machines, and for each kind we may adopt a mean value. Thus,

For a good machine with pistons, composed of cast iron cylinders truly bored and worked by a steam engine, we admit $m=0\cdot50$.

For a common machine with pistons, moved by a well constructed bucket wheel, including the inevitable losses of air, we shall have, according to my observations upon this kind of blowers,* 0·24.

If the motor water acts upon a wheel by a shock and not by the weight, it would not be over 0·14.

In hydraulic blowers, where the friction against the water is small and where there are but few losses of air, according as the wheel is struck above or below, we have $m=0\cdot30$ or $0\cdot18$.

Finally, for some well arranged "*trombes*," according to the observations of MM. Tardy and Thibaud as well as with those made by M. Marrot and myself in concert, $m=0\cdot10$.

For machines of the same kind, the co-efficients to be assigned vary up to a fifth and even a fourth more or less, according as they approach a greater or less perfection as respects construction and disposition and a good or bad maintenance.

541. *Expression of Discharge.*—That we may determine the dis-

* *Observations sur les machines soufflantes a pistons des usines a fer du sud-ouest de la France*; dans les Annales des Mines, Tome xi, 1825.

charge of a given conduit, we must free Q from the above equation, (539), and we shall have

$$Q = 26{\cdot}966 \sqrt[3]{\frac{m\,p\,h}{\frac{L}{D^5} + \frac{42}{d^4}}}.$$

If the conduit is entirely open, by increasing the co-efficient in the ratio of 4030 to 4321, (525), we shall have

$$Q = 28{\cdot}31 \sqrt[3]{\frac{m\,p\,h\,D^5}{L + 42\,D}} .$$

542. *Expression of Diameter.*—We have frequently to determine the diameter to be given to a conduit; the fundamental equation gives for this determination,

$$D = 0{\cdot}13849 \sqrt[5]{\frac{L\,Q^3}{m\,p\,h - 0{\cdot}00213\frac{Q^3}{d^4}}}.$$

The velocity of efflux is sometimes a part of the problem to be resolved. We introduce it in the formulæ by substituting for d its value as a function of V as given by the relation $Q = 0{\cdot}93\,\pi^1\,d^2\,V$; and from this substitution we have

$$D = {\cdot}13849 \sqrt[5]{\frac{L\,Q^3}{m\,p\,h - {\cdot}001136\,Q\,V^3}}.$$

543. *Conduits with Heated Air.*—In what we have thus far said, the conduits were supposed to have conveyed an air of uniform temperature. But, for several years we have found it advantageous to blow the fires of certain metallurgic works with air heated at least to 572° of thermometric temperature; consequently their conduits must pass through furnaces, which give them this high temperature. If t' is the number of degrees, let us make $1 + 0{\cdot}00208\,(t' - 32°) = T'$; and let h always be the height of the manometer of mercury placed upon the conduit immediately before the outlet ajutage we shall then have

$$Q = 948{\cdot}18\,d^2 \sqrt{h\frac{T'}{b + h}},$$

or, the air being taken at the temperature and pressure of the atmosphere,

$$Q = 948{\cdot}18\,d^2\frac{T}{b}\sqrt{h\frac{b + h}{T'}};$$

and for the useful effect e, it will be

$$e = 803660\,d^2\,h \sqrt{h\frac{T'}{b + h}}.$$

As for the dynamic effect or force to be imparted to the air on its

entering the conduit, if H is always the manometric effort at the inlet,

$$\text{we may still admit } 803660\, d^2 h \sqrt{h \frac{T'}{b+h}}.$$

But, in view of the elevation of the temperature between the points where H and h is taken, the law which unites these two quantities will no longer be that given by the experiments made at the mines of Rancié, and we cannot arrive at an expression of the force imparted similar to that of No. 537.

Still, in short conduits of a great diameter compared to that of the outlet orifice, and where, consequently, H differs but little from h, the above expression of useful effect may, with a slight increase, be taken for that of the force to be imparted. This force will be to that which would be required if the air had not been heated, h remaining the same, as $\sqrt{T}$ is to $\sqrt{T}$. Thus, for hot air at 662°, that of the atmosphere being 53·6°, the force would have been more considerable in the ratio of 149 to 100; and notwithstanding this, the quantity of air blown would have been less in the ratio of 67 to 100: it would have required more than double the force to have obtained the same quantity. Finally, by taking from the equation of discharge the value of h, and substituting it in the expression of the effect, we shall have the exact ratio between the two forces.

M. Combes, in a Memoir which we shall soon refer to, has deduced from his own peculiar theory, the following expression for the force to be imparted to air:

$$\frac{\cdot 22652 \Delta Q^3 q}{g \pi^2}\left(\frac{1}{m^2 d^4} + \frac{0\cdot 0238}{D^5}\left(\frac{L'}{\Delta} + L''\right) + \frac{2 \log.\text{hyp.}\, \Delta}{D^4}\right),$$

in which Δ is the ratio of T' to T, q the weight of a cubic foot of atmospheric air, L' the length of the portion of the conduit from the origin up to the heating furnace, L'' the other portion.

For the ratio of this force to that which would have been required for air not heated, Q remaining the same, M. Combes finds a value a little below

$$\Delta\left(1 + \frac{2\,\text{hyp.}\log.\,\Delta}{\dfrac{D^4}{m^2 d^4} + 0\cdot 0238\dfrac{L}{D}}\right).$$

544. *Examples.*—I. There is required, for a blast-furnace to smelt iron by means of coke, 35·316 cubic feet of air per second, arriving at the furnace with a velocity of 492·12 feet. It is driven by a steam engine, and the wind-trunk is to have a length of 311·67 feet, and a diameter of ·984 feet. What force must such a machine have?

The question is reduced to the determination of $p\,h$. The fundamental equation will give its immediate value, when the condition relative to the velocity is expressed therein, or, in other words, when the value of d fulfilling this condition is introduced in it; this value will be $\cdot 31344 \left(= \sqrt{\dfrac{35\cdot 316}{0\cdot 93\ \pi'\ 492\cdot 12}}\right)$. (The air may be let upon the furnace through two nozzles of 0·223 ft., or through three of 0·177 ft. diameter.)

The blasting being put in operation by a steam engine, we shall have as a mean, $m = 0\cdot 50$. Moreover, $Q = 35\cdot 316$ cub. ft., $L = 311\cdot 67$ ft., $D = 0\cdot 984$ ft., and $d = \cdot 31344$ ft.

$$\text{Thus, } p\,h = \frac{\cdot 0000509}{0\cdot 5} \times 35\cdot 316^3\left(\frac{311\cdot 67}{\cdot 984^5} + \frac{42}{(\cdot 31344)^4}\right) = 21047:$$

that is to say, there will be required a machine with a force of 21047 lbs. ft.

$$\text{or of } 39 \left(= \frac{21047}{542\cdot 69}\right) \text{ steam horse powers.}$$

If, all else being equal in the data of the problem, the diameter of the conduit, instead of being 0·984 ft., had been but 0·82, it would have required a force of 43.

"	0·65,	" "	57.
"	0·49,	" "	120.
"	0·41,	" "	254.
"	0·328,	" "	714.
"	0·31344, (equal diameter of nozzle)		889.

This shows *the advantage of giving to conduits a great diameter as compared with that of the orifices of the nozzles at their extremities*, as in the actual example.

But, experiments upon the ventilator of the mines of Rancié, furnish a striking and direct proof of this advantage. For example, in the experiments whose results are noted below, and which were made at the end of a conduit 1269 ft. long, and ·328 ft. diameter, if we represent by 1 the motive power at the origin of the conduit, the useful power remaining at the extremity, will be expressed by the numbers of the last column; and we see that they diminish, very rapidly, with the diminution of D, the diameter of the conduit, d, that of the orifice remaining the same.

D	H	h	$\frac{h}{H}$
	Feet.	Feet.	
5 d	·1774	·1555	0·88
3½ d	·1774	·1007	0·57
2½ d	·1509	·0531	0·35
2 d	·1328	·0177	0·13

II. If, in the blowers of the given example, the pistons instead of being worked by a steam engine, were driven by a bucket-wheel under a fall of 16·4 ft., all the other data of the problem remaining the same, we should have made $m = 0·24$, and should have $p\,h = 43871$ lbs. ft.; and since $h = 16·4$, $p = 2675$ lbs.; that is to say, to produce the effect required, there would be needed a current yielding 2675 lbs., or 42·839 cub. ft. of water per second.

III. A ventilator is to be built to convey 2·825 cub. ft. of air per second 4921 ft. from the machine which supplies it. This machine is a "trombe," to which we give 1·765 cub. ft., or 110·27 lbs. of water with a fall of 18·04 ft.; what should be the diameter of the conduit?

We have $Q = 2·825$ cub. ft., $L = 4921$ ft., $p = 110·27$ lbs., $h = 18·04$ ft., and (540) $m = 0·10$.

As the conduit should be entirely open at the end, we must use the second of the two equations of No. 541; it will give $D^5 = \frac{Q^2\,(L + 42\,D)}{(28·31)^2\,m\,p\,h}$. Neglecting at first the term $42\,D$, we shall have, with the above numerical values, $D^5 = ·0245$, and extracting the fifth root, $D = ·4765$. Consequently, $42\,D = 20·01$: putting this term in the formula, we shall obtain $D = ·4769$.

To provide for all miscalculation, in the execution we raise the diameter to 0·492 ft., and even more, if the size of the sheet iron plates, of which the conduit is composed, will admit of greater dimensions without a material increase of cost.

NOTE.—In 1823, I was called to establish, as I have said before (522), air conduits for the mines of Rancié. I sought among the authors who have discussed the motion of fluids for fit rules to direct me in this work, and found none. Appreciating their utility, I attempted their determination. For this purpose, I carefully observed the numerous manometric phenomena presented at the successive laying of the parts of the different conduits; and to a certain extent they dictated to me the formulæ placed in this section. They are the immediate results of experiment, they are simple, and they will amply suffice those engineers who may be engaged on similar works.

Since then, two distinguished geometricians, MM. Navier and Poncelet, taking as a basis some hypotheses, and profiting by the results of my observations, have given a mathematical and general theory of the motion of aeriform fluids. That of M. Navier may be seen in his *Mémoire sur l'écoulement des fluides élastiques dans les vases*

et les tuyaux de conduite. (*Mémoire de l'Académie des Sciences de l'Institut.* 1829.) The equation of motion established by this Savant, is

$$\mathrm{H}-h=\left(1+\left(\frac{1}{\mathrm{m}'}-1\right)^2+0{\cdot}0246\,\frac{\mathrm{L}}{\mathrm{D}}\right)\frac{h\,m^2\,d^4}{\mathrm{D}^4\left(1-\dfrac{m^2\,d^4}{\mathrm{D}^4}\right)}.$$

It differs from that which I have given in No. 523:

1st. By the term $1+\left(\frac{1}{m'}-1\right)^2$, whose value is only 1·006, and refers to the contraction experienced by the air at its entrance in the conduit. I have remarked (520) that the effect of this contraction was comprised in my co-efficient 0·0238.

2d. By the term $1-\frac{m^2\,d^4}{\mathrm{D}^4}$, which I have admitted in theory in a somewhat different form (521), but experiment induced me to suppress it. For most of the cases presented in practice, it may be neglected, and the formula of M. Poncelet will not differ sensibly from mine in its results.

Still later, in 1837, M. Combes has discussed the theoretic question of the motion of air in conduits, by a method differing in some respects from that of M. Navier. In his formula, he preserves a term relative to the weight of the air in the conduit: a term which M. Poncelet has discarded from his, since it had but a trifling influence, and which I have designedly omitted in mine, because my conduits were a little inclined; but it may have a marked effect in some circumstances, for example, in the ventilation of mine shafts, or for high chimneys of certain works. Designating by H' the difference of level between the two ends of the conduit (quantity relative to this term), by Ω the section of the conduit, by χ its perimeter, by a the section of the outlet orifice, by μ' the co-efficient of contraction relating to it, by μ that belonging to the cylindrical tubes, by p_0 the pressure at the entrance of the conduit, by ρ_1 the pressure upon the orifice of the outlet, by q_1 the weight of a cubic foot of air under the last pressure, which is that of the atmosphere, by ζ a co-efficient to be deduced from the experiment (mine gave $8\,\zeta=0{\cdot}0238$), finally, by Q the volume of air delivered, taken at the pressure and temperature of the atmosphere, M. Combes arrives at the equation,

$$\mathrm{Q}=\sqrt{\frac{2g\left(\dfrac{\rho_0-\rho_1}{q_1}\mp\mathrm{H}'\right)}{\dfrac{1}{\mu'^2a^2}-\dfrac{1}{\mu'^2\Omega^2}+\dfrac{1}{m^2\Omega^2}+\dfrac{2}{\Omega^2}\,\zeta\,\dfrac{\chi}{\Omega}\,\mathrm{L}}}.$$

For cylindrical conduits, observing that μ' does not differ sensibly from μ, and that $\frac{\rho_0-\rho_1}{q_1}=\phi\,(b+\mathrm{H})-\phi\,b=\phi\,\mathrm{H}$; ϕ being the ratio of the specific weight of mercury to that of atmospheric air ($\phi=10969$ at 2·493 ft. pressure, and 53·6° temperature), this equation reduces to

$$\mathrm{Q}=4278\sqrt{\frac{(\mathrm{H}\mp0{\cdot}0000915\,\mathrm{H}')\,\mathrm{D}^5}{\mathrm{L}+48{\cdot}6\,\dfrac{\mathrm{D}^5}{d^4}}}.$$

That which I have established is, (524)

$$\mathrm{Q}=4030\sqrt{\frac{\mathrm{H}\,\mathrm{D}^5}{\mathrm{L}+42\,\dfrac{\mathrm{D}^5}{d^4}}}.$$

(To be Continued.)

For the Journal of the Franklin Institute.

Fall of the Pemberton Mill.

We have collected from authentic sources, the following particulars relating to this ill-fated structure.

The Pemberton Mill, an extensive establishment at Lawrence in Massachusetts, was erected in 1853 by a Boston Company for the purpose of manufacturing colored cotton goods. The Essex Company, the projectors of Lawrence, and the original owners of all the mill sites and most of the available building lots in the new city, on learning the intentions of the Company to erect a large mill in some locality not very distant from Boston, were desirous of having it at Lawrence in order to get the benefit in the sale of their building lots, resulting from the considerable influx of population that would necessarily take place in connexion with such an enterprise. As an inducement, they offered to furnish the mill site and six mill powers, gratis; subject only, to the usual rent of three hundred dollars per mill power per annum, reserved on the mill powers disposed of by them. These terms were accepted, on the Essex Company's undertaking to erect such buildings, &c., as the new Company might require, at cost, on a credit of five years.

Under this contract, the building known as the Pemberton Mill was built by the Essex Company under the superintendence of their engineer, Capt. Charles H. Bigelow, formerly of the U. S. Engineer Corps. The requirements of the new establishment were specified from time to time by its proprietors represented by Mr. J. P. Putnam; and the duty of the engineer of the Essex Company appears to have been limited to the proper construction of the works. The duties and responsibilities of the different persons acting together do not, however, appear to have been defined with much precision; all seem to have been anxious to promote the enterprise, and all undoubtedly acted in good faith; but among them, they committed the errors which have been followed by such awful consequences.

The principal building, which alone fell, was of brick, two hundred and eighty-four feet long, eighty-four feet wide outside, and five stories high, with a roof nearly flat. At the northerly end was a wing, which did not fall until after the fire, sixty feet long and thirty-seven feet wide, and of the same height as the mill, in which were the counting room, cloth room, and various other offices. There were also several detached buildings, viz: the dye house, under which there were three turbine water wheels, of about two hundred horse power each, furnishing the required power for the whole establishment; the picking house, cotton house, boarding-houses, &c.

The machinery comprised about 27,000 spindles, with all the other machinery requisite for making, from the raw cotton to the finished goods, a variety of fabrics composed of white and colored yarns. The entire cost of the establishment was about eight hundred and forty thousand dollars. It was carried on about three years by the original pro-

prietors until in 1857, during the panic, they deemed it expedient to suspend manufacturing operations. Subsequently the property was sold by auction, for three hundred and twenty-five thousand dollars, to Messrs. Nevins and Howe, the proprietors at the time of the fall.

The new proprietors made no material change in any part of the establishment, and were understood to be doing a very profitable business up to the time of the catastrophe.

Within the last ten or fifteen years, a change has taken place in the character of the buildings erected in the Eastern States for the cotton manufacture. It has been found that a more advantageous arrangement of the machinery, can be made in mills of greater width than had previously been erected. Wider rooms, to be properly lighted, required larger windows, which again required higher stories and wider bays. In the conception of the Pemberton Mill, these new ideas had been pushed to an extreme; and evidently required great caution and study in those charged with its construction.

The stability of the building seems never to have been questioned, or even discussed. By the new proprietors, its unusual freedom from vibration seems to have been the only point particularly discussed, and this could have been only a subject of congratulation. All went on prosperously until Tuesday, January 10th, 1860, at a few minutes before five o'clock in the afternoon, when, without the least warning, the entire building fell to the ground; probably not more than one minute elapsing from the first crack, until the crash was over.* About six hundred and seventy persons were in the building at the time, nearly all of whom were buried in the ruins.

Three weeks after the accident, the following statement was made of the number of sufferers:

Killed outright 83, since dead 3, total dead,	86
Badly injured,	116
Injured, but not seriously,	159
Total killed and wounded,	361

The floors fell within the lines of the walls, and nearly vertically; the walls fell outwards. The machines in a cotton mill, as every one knows, are arranged in regular rows, with alleys between, generally of three feet or more in width, in which the duties of the operatives are performed. The machines in all cotton mills, as a rule, are fastened down to the floors. The floors were of four thicknesses of plank and boards, crossing each other in different directions and strongly nailed together; and when they fell, although much rent and broken, it was in large areas, on which the machines, generally, retained their places, and the frames of the machines having great strength, and a certain degree of uniformity, as to height, in each room, as the floors fell one on the other, they were prevented from coming in contact by the machines; so that after the fall, the general character of the ruins of the interior of the building, was this; the floors lay nearly horizontally, one above the other, say two to four feet apart, the spaces between them being occupied by the machines in nearly the same relative posi-

* The fall commenced near the southerly end, and extended northerly about as fast as a person could run.

tions that they occupied before the fall. The operatives must nearly all have been in the alleys, and after the fall, found themselves in spaces of the width of the alleys, and of a height nearly that of the machines. With this explanation, it is less difficult to understand how it happened that so small a proportion were killed.

At the time of the fall, the gas burners were nearly all lighted, and, at first view, it appears one of the most extraordinary circumstances connected with the catastrophe, that the ruins were not in flames the moment after the building fell. There could not have been less than one hundred tons of cotton, in various stages of manufacture, in the mill at the time. Mr. Chase, the superintendent of the mill, in his evidence before the Coroner's Jury, estimates the stock at sixty-five tons, not including the lower story occupied by the looms. Every machine had more or less cotton about it, and generally in a form highly favorable to rapid ignition. The gas was, undoubtedly, extinguished before a single burner, out of the hundreds that were lighted, came in contact with any cotton. This may have happened from the main gas pipe being among the first things broken,* or what is more probable, from the collapse of the floors, causing a pressure of air throughout the whole building, greater than the pressure of gas in the pipes; this latter is usually equal to about two inches of water above the pressure of the atmosphere, say $\frac{1}{250}$ of an atmosphere. It is easy to see that before the burners, which were attached to the ceilings, could have reached the cotton, which was, probably in all cases, two feet or more below them, the action of the falling floors, like the boards of the blacksmith's bellows, may have caused a pressure of air far exceeding this, and a very small excess of pressure would have driven the air into the pipes, through the burners, and, of course, extinguished the lights.

About four hours after the fall, the cotton in the ruins was accidentally set on fire by the breaking of a lantern in the hands of some person, among the great number at work, extricating the dead, wounded, and imprisoned. The fire was kept in check for some time by the application of immense quantities of water from hydrants, force pumps of the neighboring mills, and hand engines, all of which had been partially made ready for use immediately after the fall; but it finally gained the mastery, causing the loss of the lives of many persons imprisoned in the ruins, who would otherwise have been saved.

The general construction of the building will be understood from Plate III. Fig. 1 is a section through the centre of a beam, one side wall of the lower story, and one pillar. Fig. 2 is a section on a larger scale, at right angles to the preceding, through the top of a pillar, showing the mode of supporting the floors. Fig. 3 is a horizontal section of the side wall taken at the top of the beams of the floor forming the ceiling of the lower story. Fig. 4 is a horizontal section of the wall through the windows of either of the two lower stories.

The beams are ten feet apart, from centre to centre. The building is about eighty feet wide inside, the beams being in three lengths, sup-

* Since this passage was written, it has been ascertained that the main gas pipe and the metres were all at the northerly end of the building, which was the part that fell last.

ported at the joints by cast iron pillars, making two rows extending the whole length of the mill, and containing in all, fifty-four pillars in each story. Each beam is made of two timbers $7 \times 15\frac{1}{2}$ ins., with a space of $\frac{3}{4}$ in. between them; and, not proving stiff enough, the truss rods, $1\frac{1}{4}$ ins. diameter, were put on each side, after the building was erected. The three lengths of beams were connected together, over the pillars, by joint bolts, and the ends were anchored to the walls by irons $1\frac{1}{2} \times \frac{3}{4}$ ins., hooked on to the beams, and turned up into the wall about 9 ins., as represented in Fig. 1. On the beams was laid a uniform flooring of three-inch plank, dowelled together. On this was a thickness of one-inch boards, laid diagonally, and on this again were laid the floor-boards of Southern pine, $1\frac{1}{4}$ in. thick. Between the beams, the underside of the plank was sheathed with $\frac{7}{8}$-in. pine boards, forming the ceiling of the room below.

The system of pillars formed a continuous bearing of cast iron from the brick piers in the basement, to the roof. The pressure was transmitted through the floor beams by means of pintles, three inches in diameter, with flanges on the top, about $1\frac{1}{2}$ in. thick, to receive the bases of the pillars above. This arrangement is shown in Fig. 2. The bearing surfaces were left as they came from the foundry, except the ends of the pillars, which had been chipped off by hand.

The lower pillars rested on brick piers, from two to three feet in height, which again rested on stone foundations. A portion of the piers were first built one foot square, but this not giving a convenient bearing for the lower floor, they were enlarged by a course of half a brick thick all round them. (See Fig. 1.) This, of course, did not materially add to the strength of the piers to bear the pillars. These piers were of very well burned brick, laid in hydraulic cement, and none of them exhibit any signs of failure, although carrying fully 60 per cent. more weight than is deemed the safe limit by the best authorities.*

Most of the pillars were found broken after the fall, and the fractures disclose very great defects in the quality of the castings, being full of blow-holes, cold shuts, and thin places. All except those in the upper story supporting the roof, were hollow, and the fractures disclose that the cores were made in pieces insufficiently supported in the mould, and with no connexion between them for the escape of steam or gas, the iron in some places forming a diaphragm at the junction of the cores. These defective pillars were, undoubtedly, the primary cause of the disaster; and, the only wonder is that they should have stood so long as they did. They were furnished by the Eagle Iron Foundry in Boston, for $8·50 each, under a contract with Mr. Putnam, the agent of the proprietors.

Figs. 3 and 4 show the construction of the walls. Not considering the pilasters, they were of uniform thickness in all the stories, and contained air spaces, or vaults, as they are termed at Lawrence. The whole thickness was twenty inches, formed of an outer and inner wall of a thickness equal to the length of one brick, or $7\frac{1}{2}$ ins.; leaving an air space of 5 ins. The two walls were connected, on an average, every two and a half feet, the main connexions, which were opposite

* Morin, Aide Memoire, p. 332.

each beam, being a whole brick in width; the others half a brick each. In addition to this uniform wall, the two lower stories had pilasters, where the beams rested on the walls; they were 2 ft. 10 ins. wide, and projected into the rooms one brick or 7¾ ins. The mortar was composed of lime and sand of good quality, and apparently well made. The windows were unusually large, taking out of the brick-work, on the outside, a width of 4 ft. 9 ins., and on the inside, 5 ft. 1 in., and were 10 ft. high. The foundations of the building appear to have been sufficient; at any rate, the fall is in no degree to be attributed to any defect in them.

The following is the testimony of a witness, examined chiefly as an expert, before the jury of inquest, as taken down in brief by their clerk, and subsequently corrected by the witness as far as practicable, and subscribed by him in the usual form.

James B. Francis, being called and sworn, testifies as follows:— I reside in Lowell. I am an engineer employed by the various corporations there, and agent of the Locks and Canals Company. I have been employed as an engineer, by the Locks and Canals Company, rather more than twenty-five years; my connexion with the rest of the companies has been about fourteen years. During this time, I have been consulted in regard to the building of various mills. Have been called on to design various parts of the mills, principally relating to the foundations, the power, the wheel-pits, the main gearing, the strength of floors, and of pillars. My business has been mainly connected with the water power and the construction of mills.

The year before this mill was built, I was asked by Mr. Putnam, who was at the time Treasurer of the Boott Cotton Mills at Lowell, in relation to the pillars of a mill he was then intending to erect at Lawrence; what was said, I cannot now recollect, but I subsequently wrote him the following letter:

Dear Sir:—Assuming that the weight on the lower columns is the same as that on the corresponding columns of the Prescott Spinning Mill, a column seven inches in diameter and half an inch thick, would give ample strength, provided it could be properly cast. I should think it would be better to make it six inches diameter, and three-quarters of an inch thick, which gives an abundant margin for all contingencies. Of course, any column which has manifest imperfections should be rejected, but my calculation is intended to cover all ordinary imperfections. Of course the columns in the upper stories may be gradually diminished in size and thickness.

Very respectfully, Yours,

Lowell, Dec. 18, 1852. James B. Francis.

A diagram in the margin of the letter, indicates that a five story mill, eighty feet wide, was contemplated.

As now informed, the area of floor supported by each column in the Pemberton Mill, is fully double that supported by each corresponding column of the Prescott Spinning Mill; and, consequently, each column has to support double the weight at the Pemberton Mill, as at the Prescott. This, of course, is assuming that the weight per square foot of floor is as great at the Pemberton as at the Prescott, of which I suppose there can be no doubt.

At the Prescott Mill, the beams are eight feet apart, these are ten

feet apart; the space from column to column at the Prescott Mill, is sixteen feet, here nearly twenty-seven feet. The product of 8 by 16, equals 128 square feet; that multiplied by the number of stories (four), equals 512 square feet of floor, which is supported by each column in the lower story of the Prescott. In the Pemberton Mill, 26 ft. 10 ins., by 10 × 4, equals 1073 square feet, which is supported by each column in the lower story; the roof being also supported in addition at the Pemberton. The roof when loaded with snow, might be equal to one-third or one-half another floor. When I have made an estimate of the strength of columns, it has been based on what weight they would have to support. I always made an estimate, or have been furnished with one, for each particular case, when called on to calculate the strength of columns. As I recollect now, it has been my rule to make the columns of that size which would require a weight twelve or fifteen times greater than they will be required to support, to crush them.* When I say it would take twelve or fifteen times the weight to crush a column, I mean a column made and set as perfectly as the columns from which the rules are deduced.

I have in my possession, estimates which have been made of the weight per square foot of machinery on the different floors of mills.

By a column six inches in diameter, I should understand that this was the diameter at the middle. A column five and three-quarters inches in diameter, five-eighths inch thick, and twelve feet long, (which is said to be the size of the columns in the lower story of the Pemberton Mill,) according to the rule given by Hodgkinson,† has a breaking weight of two hundred and thirty-one tons. A column, five and a half inches in diameter, five-eighths inch thick, and twelve feet long, by the same rule, has a breaking weight of two hundred and three tons

* At first sight, this appears an excessive allowance, but the following considerations will show that it is no more than is required for security.

Hodgkinson's formula (Philo. Trans. 1840.) is deduced from pillars with flat ends, very carefully fitted, so that the pressure would be uniformly distributed. He found that when a pillar is so fixed that the pressure is in the direction of the diagonal, its strength is diminished to one-third; and, it is highly probable, that in a pillar in which the core is not central, this would not be the weakest position. As pillars are ordinarily fitted and put up, nothing else could be safely relied on, except such an unfavorable position. We must therefore assume that the breaking weight is diminished to at least one-third, by imperfections in the bearing surfaces.

The pillars from which the formula is deduced, were cast with great care, and were either perfectly straight or were rendered so in the lathe. They were of a superior quality of iron, (Low Moor, No. 3.) Their dimensions were much less than are usual in practice. It is well known that iron cast in large masses is of less strength, both tensile and crushing, than when cast in small masses, and, in long pillars, both these qualities are essential to their strength. Again. The breaking weight found by experiment, was one that would cause fracture in a short time, in a pillar not in a state of sensible vibration; whereas, in practice, time is unlimited, and the vibration (at least in mills) very apparent. Finally, the formula is an empirical one, and consequently not to be trusted implicitly much beyond the limits of the experiments on which it is founded. It is impossible to estimate with precision the diminution of strength in practice due to these causes; all must agree, however, that one-half is not an excessive allowance. Adopting this, and combining it with the preceding one-third for imperfect bearing at the ends, we have one-sixth of the breaking weight, as computed by the formula for pillars with flat ends, as the breaking weight of cast iron pillars, as ordinarily made and set up.

So far we have no margin for safety; what this should be, depends in part upon the amount of mischief that would be caused by a failure, and also upon the degree of confidence in the founder and fitter-up. Two, two and a half, or even three times, could not be considered excessive. These numbers combined with the preceding one-sixth, gives a breaking weight *by the formula*, twelve, fifteen, or eighteen times greater than the actual weight to be supported.

† Experimental researches on the strength and other properties of cast iron by Eaton Hodgkinson, London, 1846, p. 334. The formula given for hollow pillars, whose ends are flat and firmly fixed, is

$$\text{Strength in tons, (of 2240 lbs.)} = 44{\cdot}3 \times \frac{D^{3.6} - d^{3.6}}{l^{1.7}}$$

from which we deduce

$$\text{Strength in tons, (of 2000 lbs.)} = 49{\cdot}61 \times \frac{D^{3.6} - d^{3.6}}{l^{1.7}}$$

A column, five and three-eighths inches in diameter, five-eighths inch thick, and twelve feet long, has, by the same rule, a breaking weight of one hundred and ninety tons. These calculations are made from pillars accurately set; the rule was deduced from a number of columns of various sizes, made of good iron, of one uniform kind, and mostly cast in dry sand vertically, and all pains taken to get the cores exactly central, but they did not succeed in many cases.

I selected several of the experiments given by Hodgkinson, and calculated what the pillars should bear by the rule, and compared it with what they did bear by experiment. I selected a column, in which the thickness was uniform all round at the place of fracture, as a standard; calling the strength of this 100; another, where the metal was twice as thick on the one side as on the other, the strength was 98; another, in which the metal was five times as thick on one side as on the other, the strength was 84. But this should not be taken as the true representation of the fact, in general, as the experiments were too few; they, however, indicate that there is not so much difference in strength from this cause, as might be supposed.

If that capital* had been of good iron, five-eighths of an inch thick, and making part of a column five-eighths-inch thick, it is immaterial if it is only stronger, which I think it is, than the weakest part of the column, which is usually half way up. The fact of the bulging of the capital does not add nor detract from the strength of the column, provided it is still stronger than the weakest part of the column, which I believe it is.

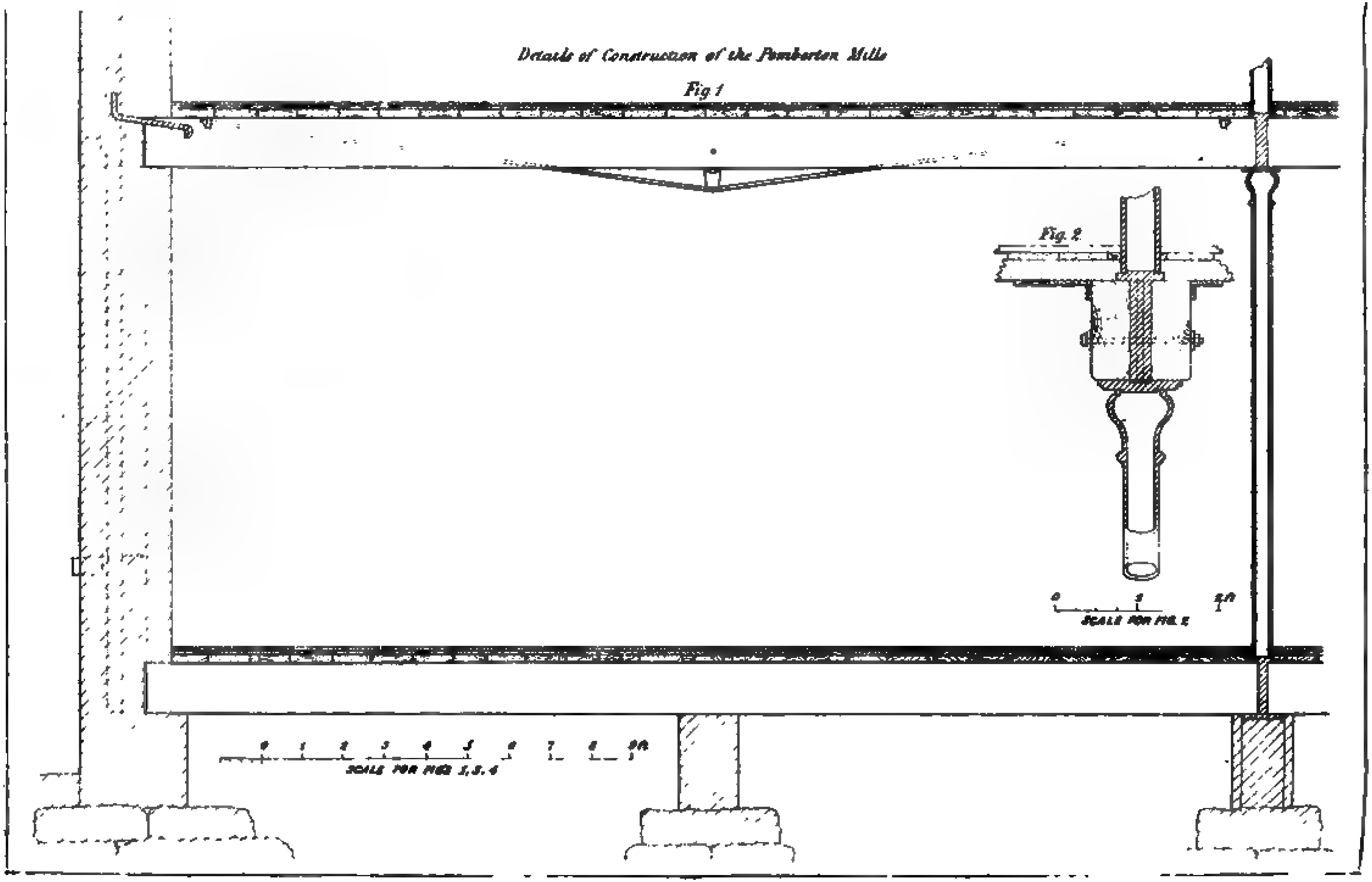
The breaking weight of a pintle, with a flanch, seven inches in diameter, one and one-eighth inches thick, on the top of the pintle three inches in diameter, with a column resting on it, five and three-fourths inches in diameter outside, and half an inch thick, placed concentrically with the flanch and pintle, the top of the flanch being uneven, as castings usually are, I think would not be far from forty-five tons. The safe weight, in my opinion, would be one-fourth part of this; one-fifth would be safer; certainly not more than one-third of this would be safe. It does not require so large a margin for security as hollow columns. If on the same pintle a pillar of six inches had been placed, I should have considered it weaker. I do not think that the fact of heavy timbers being under the flanch of the pintle made it any less liable to break.

Estimating the weight as follows:

Machinery on second floor, as given by Mr. Chase,	275	tons.
" third " " "	150	"
" fourth " " "	100	"
" fifth " " "	75	"
Shafting, as given by Mr. Burke,	125	"
500 people at sixteen to the ton,	31	"
Stock on upper floors, as given by Mr. Chase,	65	"
Piping and columns, estimated at	60	"
4½ floors, estimated at 25 lbs. per square foot,	1260	"
Total,	2141	tons.

* See Plate, Fig. 2.

Details of Construction of the Pemberton Mills



One-third of this weight rests on the side walls; reckoning two columns for the ends of the mill, making in all equal to fifty-six columns, and dividing the remaining two-thirds of the whole weight by that number, gives about twenty-five tons on each of the lower columns. This would be between one-ninth and one-tenth of the breaking weight, as calculated by Hodgkinson's rule, of the columns in the lower story.

Provided the columns are as perfect as columns are usually made for mills in this neighborhood, I cannot call this unsafe, although not so large a margin of safety as I would recommend; but as the columns turn out to be on examination, I consider it entirely unsafe. The weight of twenty-five tons on the pintles, being more than one-half of the calculated breaking weight, I should consider unsafe, even if all the castings were perfectly sound. If these columns had been as perfect as they ordinarily are, and a pintle had broken, I think it would not have caused the mill to fall. There would have been a shock, equivalent to a great additional weight; but, if the column came down on the beam, as I suppose it would, and did not crush through, I think it would not have endangered the whole structure.

If this plan of pintle had been brought to me, I should have gone through a similar calculation to that I have here, and think I must have arrived at a similar conclusion.

I think there ought to have been another row of columns; twenty-seven feet is too great a span as we get materials here.

If I were to build a thin vaulted wall, I should put a portion of cement in the mortar. All vaulted walls which I know of, except these, have cement in the mortar. I should prefer solid walls, if laid in lime mortar, without cement. Our practice at Lowell, has been to build thicker walls. I dont think any disaster would have followed from the walls, if the interior arrangement of the mill had been good. If the walls had been as thick as our Lowell walls, and several of the pillars had given way near together, I should have expected the walls to fall. The fact of the walls remaining true to the lines, and the building free from cracks, would give confidence in the strength of the walls, and the strongest reason to think that the trouble originated from the inside. The fact of the windows being so large, would render the wall weaker than if they were smaller. My opinion of the original cause of the disaster is, that it was something connected with the pillars; but, if the supports generally had been sufficient, and the walls stronger, the giving way of one support would not have caused the whole structure to come down. The fact of cracks by the side of the chimney, would not lead me to distrust the strength of the mill, because such cracks are to be expected where a large and lofty chimney is joined to a building.

As far as I know, it has not been a custom to make any systematic examination of the pillars at Lowell; the parties who furnish the pillars are considered responsible for them. I don't know that I ever heard of an iron column breaking before these. If the columns were coming from persons whom I knew nothing about, and I had any suspicions, I think they would be looked after more closely. I think

some columns have been objected to on account of their crookedness. The fact that these columns have stood six years, poor castings as they are, gives me great confidence in the safety of iron columns as usually made for mills. JAMES B. FRANCIS.

JAMES B. FRANCIS, *re-called.*—If the original cause of the disaster was the failure of a column or pintle, the weakness of the walls greatly increased the danger of the whole mill falling, as it did. The flanch of the pintle being an ordinary rough casting, and the bottom of the column not accurately fitted to the casting, it follows that the weight could not have been uniformly distributed all round the flanch, and in many cases, most of the weight must have been on two points; and in some cases, I have no doubt, half the weight was on a single point, or on a very small part of the surface of the flanch; and in making my calculation of the breaking weight of the pintle, I have so assumed it to be.

The particular circumstances in each case govern the foundation walls for mills. A reason why the foundations in many of the Lowell mills are so deep, is, that the wheel-pits are under the mills; where the wheel-pits are not under the mills, it would not, generally, require the foundations to go so deep.

Most of the mills at Lowell are four stories and a basement in height; four stories in front, five stories on back; the thickness of the brick walls in the basement, is usually two feet; the next two stories, twenty inches, and the next two stories, sixteen inches; solid walls laid in lime mortar without pilasters. Windows are about three and a half feet wide and six feet high. The floor timbers are eight feet apart and about thirteen by fifteen inches, not spliced. Floors are of three inch plank with a boarding above and sheathing below, making in all about four and three-quarters inches. The width of the mills inside is from forty-one to forty-four feet with one row of columns. Length of mills inside, about one hundred and fifty-three feet. Some of the new mills are of quite different dimensions from these. Think the walls of mills with deepest foundations, laid with common dry walls, are liable to crack the most.

I looked at some parts of the foundations of the Pemberton Mill, and found no perceptible settling. The fact that the mill stood so long without injurious settlement, is good evidence that the foundation was sufficient. The soil here is very similar to that at Lowell, and I should think there would be no unusual difficulty in getting good foundations.

JAMES B. FRANCIS.

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*Steel Bell Casting at Sheffield.**

A large number of persons lately assembled at the works of Messrs. Naylor, Vickers & Co., Millsands, to witness the casting of the largest steel bell which has yet been produced in Sheffield. The bell, which was designed by Mr. Roddewig, the engineer of the firm, is to be used as a fire-alarm bell in the city of San Francisco. A large iron vessel, plugged at the bottom, says the *Sheffield Independent*, was placed in

* From the Lond. Builder, No. 880.

the pit, above the mould, to act as a funnel, and the molten steel was poured into it from the crucibles. The moment that part of the process was finished, the plug was drawn from the bottom of the funnel by means of a crane. The fiery liquid then ran into the mould in a copious and uninterrupted stream, and the work of casting was complete. When the metal was sufficiently cooled to permit of an examination, it was found that all had gone right, and that the casting was perfectly sound. The weight is 2 tons 12 cwt., or 5824 lbs., and the dimensions are,—Height, 5 feet 3 inches; diameter at the mouth, 6 feet 2 inches; thickness at the sound-bow, (where the clapper strikes,) 4¼ inches. Messrs. Naylor, Vickers & Co. cast their first bell in 1855, and have since turned out 1300. Steel is considerably cheaper than "bell metal," and also stronger, so that a much smaller weight suffices for any required result, thus making the difference between the price of the two kinds of bells even greater than is represented by the difference in the cost of the material per weight.

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*Improvements in the Manufacture of Umbrellas, Parasols, Hats or Hat Covers, Caps, Capes, Coats, Mantles, Dresses, Gloves, and other similar articles.** STEPHEN BARNWELL and ALEXANDER ROLLASON.

Collodion and castor oil have received a new application. Messrs. Barnwell and Rollason use the mixture for making silks and other woven fabrics water-proof. Their manner of proceeding is as follows: "Assuming the material under operation to be silk, we take collodion and mix it with vegetable oil, such as either hemp-seed, rape, olive, almond, nut, poppy, castor, cotton, or linseed oil in the purest possible state, and we find that such oils when mixed with collodion, undergo a change upon being subjected to heat, and this change or decomposition is highly advantageous in the subsequent processes to which the silk will be applied. The mixture of collodion and oil is spread or poured upon plates or cylinders of metal or glass, and before it is quite set the silk is laid or rolled over it and immediately removed, bringing away with it a thin film of collodion and oil. The silk thus coated is now removed to a stove or drying oven and submitted to a heat of 100° to 300° Fahrenheit, by which the mixture undergoes the before named change or decomposition, and the result is, that a slightly glazed appearance is imparted to the silk, which is at the same time considerably strengthened or thickened, and may be rendered almost or quite opaque by the mixture of coloring or thickening matter with the collodion and oil. A thin silk is thus rendered equal in strength to a more costly one, and the quality of imperviousness to water, which the material possesses in a high degree, will be of service."

The patentees prepare their collodion with gun cotton or with xyloidine made from hemp, flax, jute, straw, saw-dust, or starch, which they dissolve in any of the solvents of gun cotton and mix with any of the oils before-mentioned, adding only so much of the oil or mixed oils as will be freely taken up by the solution. If they desire the

* From the Chemical News, January, 1860.

coated silk or other fabric to be soft and pliable in its nature, they add a small quantity of animal oil to the solution. The proportions the patentees use for coating silk are 30 parts of the xyloidine dissolved in *about* 300 parts by weight of ether, with 100 parts of spirits of wine, with which is mixed from 75 to 100 parts of vegetable oils. This solution is allowed to evaporate in a still until it arrives at such a density that it will only just flow evenly over a glass plate, so as finally to leave a substantial film behind it.

If the patentees can make some light and inexpensive fabric waterproof, and at the same time soft and pliable, it would be extensively used by surgeons. Oiled silk is expensive, and the oiled calico and gutta percha tissue, sometimes used in its stead, lack the softness and pliability desired. The article we have suggested is greatly desired in our large hospitals.

For the Journal of the Franklin Institute.

Particulars of the Steamer Peruano.

Hull built by J. Westervelt & Sons. Machinery by Morgan Iron Works, New York. Owners, Chas. A. Denion & Os.

HULL.—			
Length on deck,		180 feet.	
Breadth of beam (molded),		29 "	3 inches.
Frames—molded, 12 ins.—sided $7\frac{1}{2}$ ins.—apart from centres, 30 ins.; strapped with diagonal and double laid braces, $4\frac{1}{2} \times \frac{5}{8}$-in.			
Keel—13 ins. deep.			
Bulkheads,	Three.		
Depth of hold, to spar deck,		11 "	
Length of engine and boiler room,		65 "	
Draft, forward and aft,		7 "	
Tonnage,	560.		
Area of immersed section at load draft of 7 feet, 170 sq. ft.			
Masts, two—Rig, schooner.			
ENGINE.—Vertical beam.			
Diameter of cylinder,			44 inches.
Length of stroke,		11 feet.	
Maximum pressure of steam,	25 lbs.		
BOILERS.—Two—Return flued.			
Length of boilers,		24 feet.	
Breadth "		5 "	6 inches.
Height "		5 "	2 "
Number of furnaces,	2 in each.		
Length of grate bars,		6 "	9 "
Number of flues,	10.		
Internal diameter of flues,	12, 15, and 16 ins.		
Length of flues, above,		20 "	
Length of flues, below,		14 "	
Diameter of smoke pipe,		4 "	10 "
Height "		32 "	
PADDLE WHEELS.			
Diameter over boards,		27 feet	6 inches.
Length of blades,		7 "	
Depth "			22 "
Number "	24.		

Remarks.—One independent steam, fire, and bilge pump. Cabin on spar deck. Date of trial, February, 1860. C. H. H.

For the Journal of the Franklin Institute.

Collection of Observations on the Day-light Meteor of Nov. 15, 1859, *with remarks on the same.* By Benjamin V. Marsh.

(Continued from page 210.)

Newburyport, Mass.

Dr. H. C. Perkins, in a letter to Prof. Henry, says, "Miss A. Brockway saw it, about 8° or 10° high, moving towards the horizon in a S.S.W. direction. It was of a brilliant yellow color, and resembled a rocket."

Alexandria, Va.

Caleb S. Hallowell, Principal of the High School, was in the open air in company with his students, several of whom saw the meteor. In a notice published at the time they say, "The sun was shining brightly, notwithstanding which, the light given out by the moving mass was brilliant in the extreme. It appeared in the east about 45° above the horizon, and ranging from thence in a *northerly* direction, obliquely towards the earth. In appearance, it most resembled a cone, moving base foremost, with an entire length of about 10°, the edges being of a silvery lustre, and the centre red."

Recently, Mr. H. says, that Abram Martin, a student particularly well qualified for such observations, "was, fortunately, standing perfectly still, with the meteorite in full view during its entire visibility; and he seems completely to have daguerreotyped its path and its appearance on his mind. By my direction, he made at the time a careful note of the spot where it fell; and, as to the point in the heavens from whence it originated, he, on two *independent* and *distinct* trials, pointed the telescope of the theodolite very nearly to the same spot, as given below.—

	1st obs'n.	2d obs'n.	Mean.
Apparent altitude at moment of appearance, . .	40°	39½°	39¾°
Azimuth " " .	N. 83 E.	N. 85 E.	N. 84 E.
Apparent altitude at moment of disappearance behind houses, ...	11°	10°	10½°
Azimuth " " . .	N. 77 E.	N. 76 E.	N. 76½ E.

"The path of the body was slightly curved, being convex towards the earth. It appeared as a cone with a flat base of about half the diameter of the moon, the central part of the train being red, and the edges intensely bright yellow, nearly as bright as the sun, the brightness at the edges being more intense than at the centre."

Petersburg, Va.

T. C. Garrison says, "When first seen, about 30° above the horizon, descending in a vertical line, throwing off brilliant corruscations, resembling scintillations from molten iron. The body of the meteor resembled in color, iron of a red heat. The scintillations were of a dazzling brightness, and resembled a shower of sparks of large size. It seemed to fall to the earth within 500 yards of my position. I saw it but for a moment. Its brilliancy was intense. Time about 9·20, but my watch somewhat uncertain."

Mr. G. sends a sketch of the relative positions of the meteor and

the sun, which shows the elevation of the meteor, when first seen, to have been about one-third greater than that of the sun.

At Beasley's Point, N. J.

Samuel Ashmead says, "The day was calm, atmosphere perfectly clear, and not a cloud to be seen. A sudden flash of light exceeding that of the sun (which was shining brightly) was soon followed by a terrific rattling noise immediately overhead. I was out of doors at the time, and could compare the noise to nothing else than the discharge of a thousand cannons in the shortest space of time, *without any two guns exploding at the same moment.* These explosions were *sharp* and *distinct*, not like the prolonged roll of thunder, and continued at least one minute. The course of the meteor was rapid from north-east to south-west, leaving behind a curling track of a smoky or light cloudy appearance, which in a few minutes melted away in the atmosphere. According to the opinion of several persons, the interval between the flash and report was about one minute."

Mr. Ashmead further says that the form of the cloud was oblong, its diameter perhaps twice that of the moon, and its length many times greater—the western end more distinct than the eastern. The sound which first reached him, was a kind of *fluttering* or *rushing sound*, comparatively faint, conveying the impression that a horse was running away; that he looked up, and just then came the crashing thundering sound, already described.

At Dennisville, Cape May County, N. J.

Dr. M. Beesley says, "I was reading in my house about half-past nine o'clock, when the report commenced, which was similar to that made by a chimney when burning out at full blast. I immediately went out of doors, and there discovered that the noise was directly overhead, and might have been compared to a train of cars passing rapidly over a rough road, with incessant detonations which seemed to be of an explosive character, much resembling a distant park of artillery.

There was a small cloud or belt of white smoke left in the train of it about 5° N. W. of the zenith, the atmosphere being perfectly clear at the time, and it passed off in a N. E. direction.

The detonations and rushing sounds lasted something over a minute, when, *after an entire suspension*, they were faintly repeated again, far off in the N. E.

It created very general alarm throughout the country. Numbers saw a flash of light precede the report. It was so near us, that dishes were moved standing upon stoves, and sash trembled, and the first thought that struck me, on going out of doors, was, that an earthquake was in progress near us. The detonations, from all the information I can get, were louder and more apparent here than at any other place. In fact, they were absolutely alarming, many people quitting their work in consequence of it, and one man went home and told his wife, that time was nearly at an end, for the Angel Gabriel had given the first blast of his trumpet."

Judge Goff, 5 miles west of me, says, "The smoke was at an elevation of 60° or 70° eastwardly." Samuel Springer of Dyas Creek, 8 miles S. W., says, "It was north-westward—elevated about 60°—and

on the sea-shore road, 5 miles east, I learn it was about 60° westwardly—and at this place, it was about 5° N. W. of zenith. This cloud of smoke, or rather, it had the appearance of steam as it passes from the pipe of a steamboat, occupied but a small space, and that near the zenith."

Dyer's Creek, Cape May County, N. J.

A. Smith says, "Several saw clouds of a roundish form, others, columns of smoke as that rising from the firing of artillery. The noise was great, lasted two or three minutes, shaking the house I was in so much that the shutters jostled on the hinges. The sound was very much like that of a wagon full of empty barrels driven furiously over a rough road, or a train of cars passing over a bridge. Horses were frightened and cattle huddled together in the fields. Some persons saw a flash—I saw it in the house about three minutes before the report. It was similar to the reflection of the sun from a looking-glass. The smoke was seen by many, in a north-east direction, elevation 75° to 80°. The form is differently stated. Some say it was roundish; others, that it rose in form of columns, three in number. The clouds were small; seemed to diverge as they shot up. The noise was at no time very much louder than at others, yet it began by growing gradually louder, and then, as gradually grew fainter."

Fishing Creek, Cape May County, N. J.

L. Cummings says, "Heard a low rumbling sound in the north-east, which gradually grew louder, resembling thunder. Saw, in the direction of the sound about 60° above the horizon, a round body twice the size of the full moon, and very near the color of the moon in the day-time, having something like a tail pointing towards the sun. I first thought it a balloon. The noise changed from a rumbling to a crackling sound like the flapping or fluttering of a loose sail in a heavy wind, and gradually ceased with the flapping sound. The body looked like smoke and soon began to change its shape, break in pieces, and roll away to the eastward. When first seen, it appeared to be moving slowly in a north-east course. In two minutes all was gone. Some saw a bright gleam of light pass through the room before the rumbling began. The sound appeared very heavy, causing windows to shake, and other bodies seemed to jar and tremble. It was not over the bay. Many thought their houses or chimneys were on fire, and others thought horses were running away."

Mouth of Antuxet, Delaware Bay.

Capt. Harris, of the *Miller's Daughter*, saw nothing; heard a noise about east. It lasted about three minutes. At first resembled the sound of a cannon in a calm cloudy morning, being a kind of prolonged roar and not a sudden explosion; afterwards a kind of quivering noise; finally pronounced it an earthquake. Resides at Maurice River Cove. The oystermen there told him they saw a ball of fire as large as a barrel. That it burst and balls of fire flew all around. On shore people thought chimneys on fire. Some within doors saw a bright flash on the bricks.

Egg Island.

Vessels shaken so much that one captain thought his vessel was grazing bottom. Sounded and found deep water. Saw a longish cloud east or north-east, at an elevation of, say, 20°. Roaring noise.

Maurice River Cove.

Many captains of oyster-boats there heard noise in easternly direction. Vessels shaken. Nothing seen or heard over the bay.

East Point, Cumberland County, N. J.

J. H. Zane was in a field one mile north-east of East Point. "At first thought it was thunder. Looked, but saw no cloud or fire. Sound came from north-east or perhaps a little further east—was quite loud, seemed near the earth, very much like thunder. Some of my neighbors saw fire and smoke three minutes. I didn't hear it three minutes, scarcely two."

Four miles west of Dover, Del.

P. F. Nickerson says he was in a carriage. His wife saw the meteor and called his attention to it; but he only saw "the trail as a silvery vapor or smoke," direction due east. The column was nearly or quite vertical, its base 20°, and its top 40° above the horizon. "Of a silvery appearance, and disappeared at the bottom end first as smoke would, only it did not spread or ascend, but disappeared in the distance; was visible 8 or 10 minutes; heard no sound, owing perhaps to the noise made by the carriage."

Lewistown, Del. Robert West sends the following:

L. D. Martin, near Lake Newbold, heard noise ¾ to 1 minute; supposed a ship had let go her anchor, the noise resembling that of a heavy chain. Direction, that of Cape May. Saw no light. His children saw "an instantaneous light, like the reflection of the sun on glass or bright metal."

George M. Cooper, Lake Newbold, was at work in his field. First thought it thunder; then, seeing no cloud, concluded it the wheels of a large steamer; thought of an earthquake. Direction, that of Cape May.

A lady 1½ miles south-west of Lewistown, was riding north-east towards town; saw a bright light enveloped in smoke—thundering or loud rumbling noise at same time. Was greatly alarmed, so that she stopped at the house of a friend, near by.

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From the nature of the case, most of the preceding observations are necessarily very uncertain, but the discrepancies are scarcely greater than might fairly be expected. It is well known that persons unaccustomed to such observations, are pretty sure greatly to overestimate altitudes, and underrate zenith distances; and it will no doubt be found that most of the altitudes given above will require reduction. The observations as a whole, seem to me best represented by the following, which are, of course, only rude approximations, but may perhaps serve to pave the way for something more exact.

1. The inclination of the meteor's path to the vertical, was probably about 35°, and the direction of its motion nearly west. The observations at Medford and Petersburg, indicate a much more southerly movement, but those at Washington, Alexandria, and Dover, require it to have been almost due west.

2. The column of smoke was near 1000 feet in diameter, and its base was vertical about 4 miles north of Dennisville, at a height of near 8 miles, which may be assumed to be the approximate position

of one point in the meteor's path. The height is inferred not merely from the angular elevations of the smoke as seen from different points, but from the interval between the flash and the report, as observed at Beasley's Point.

This position assigned to the base of the cloud, from local reports, coincides pretty nearly with that indicated by distant observations.

At New Haven, latitude 41° 18′ 18″, longitude 72° 55′ 10″, at an elevation of 6°, the bearing was S. 35° 34′ W., and at Alexandria, latitude 38° 49′, longitude 77° 4′, at an elevation of 10½°, it was N. 76½° E. These directions meet half a mile west of Dennisville in latitude 39° 11½′, longitude 74° 50½′. The line from New Haven having a vertical height at this point of 22½ miles, and that from Alexandria, 24½ miles. Continuing the path, as observed at Alexandria, down to 9½° elevation, we have corresponding azimuth 76½°, and the lines then meet half a mile north-west of Dennisville at a height of 22½ miles; but this makes the nearest point in the meteor's path 24 miles from Beasley's Point, and consequently, the interval there between the flash and the report two minutes instead of one, as observed. Besides, the observations on the smoke show pretty clearly that the minimum height at Dennisville could not have exceeded ten miles. We must, therefore, conclude the meteor's actual position to have been several miles east of that indicated by these distant observations.*

3. On the above supposition, the meteor's path would reach the earth near Hughesville, on the north-western boundary of Cape May County, in which vicinity, or perhaps still further west, it is probable that the meteor or some of its fragments will yet be found.

4. Some observers must have seen the meteor at a height of more than 100 miles; and, to have completed its path within their estimates of time, it must have had a velocity of from 30 to 50 miles per second.

The extreme shortness of the time occupied in its flight, is proved not merely by the estimates of several observers, but by the failure of people in the vicinity of the explosion to distinguish the source of the sudden flash of light seen by them, and by the impression of even the most distant observers, that it fell very near to them.

5. The sound was explosive, and *not* caused by the falling in of the air after the meteor. In the latter case, it must have been continuous and uninterrupted; but the testimony of Dr. Beesley, and others, shows that it ceased entirely and then began again. Supposing the meteor to have been a stony mass, we may, perhaps, consider the explosion to have consisted of a series of decrepitations caused by the sudden

* J. P. Pirsson, while passing along Broadway, directly opposite Bond Street, New York, saw the meteor, and immediately stopped to fix its bearing.

In a notice published at the time, he says, "It disappeared behind the tall iron warehouse opposite St. Thomas' Church, and in a line, from my position, with the white sign painted upon its north wall, near the front," its inclination to the vertical being 30° to 40° westward.

Since the above was in type, Hugh D. Vail has visited the spot with Mr. P., and by measurement with a theodolite, has ascertained that the apparent elevation of the point of disappearance was 8° 40′, and the angle made with Broadway, about 9° 2′.

According to the "Harbor Commissioners' Map," Broadway runs S. 32° 31′ W., which makes the bearing of the meteor S. 23° 29′ W.

This line crosses the parallel of Hughesville (39° 15′) in longitude 74° 49¼′, at a height of 18·7 miles, and reaches that of 39° 11½′, in longitude 74° 50½′; so that the lines from Alexandria, New Haven, and New York, all pass exactly over this spot, at the heights of 24½, 22½, and 18¾ miles, respectively; which would bring the meteor to the earth at the distances of 17, 15½, and 13 miles westward from this point.

Supposing it to have been on the parallel of Hughesville, this observation makes it reach the earth 8 miles west of that village.

expansion of the surface, the whole time of flight not being sufficient to allow the heat to penetrate the mass. At the forward end these explosions would take place under great pressure, which may account for the loudness of the sound.

6. The estimated duration of the sound at Beasley's Point, was not less than one minute; indicating that the most distant point of the explosion was not less than 12 miles further from that place than its nearest point. Comparing this with the position of the assumed path, we find, that during the explosion, the meteor must have traveled 15 or 20 miles, occupying about half a second of time.

7. The explosions were very numerous, arranged in two series, the whole occupying only ½ second of time; but the individual sounds were distinguishable, because of the different distances they had to travel to reach the ear. The velocity of the meteor being more than one hundred times that of sound, the reports must have come in the order of distance, and *not* in the order of their occurrence, causing the end of the explosion to be heard before the beginning. The faint rushing sounds first heard by Mr. Ashmead, must have had their origin below the explosion, and been caused by the flight of the fragments towards the earth. If the direction of this *first faint* sound could be indicated by persons further west, it might serve to point to the place where fragments fell.

8. The meteor lost its luminosity with the explosion or shortly after, and hence was not seen by persons in Cape May County and vicinity, it being too much overhead to come within the ordinary range of vision, and the time of flight being too short to allow them to direct their eyes to it after seeing the flash.

If the heat be due to the resistance of the air, it must be principally developed at the surface of the forward half of the meteor. Consequently, most of the explosions must occur there, and the force of each be directed backward, tending to check the velocity of the mass. In fact, we may perhaps consider the series of explosions to be merely one of the forms of the atmosphere resistance. This must increase rapidly with the density, although it may be insufficient to account for so great a reduction of speed as would entirely destroy the luminosity of the meteor before it reached the earth.

9. From the tremendous force of the explosion, and from the fact that this meteor was seen by persons who were not within two hundred miles of any part of its path, as at Salem, Mass., and Petersburg, Va., we must certainly conclude that it was of very considerable size; but we seem to have no data for any approximation to its actual dimensions. It was certainly heated to a most intense brightness, and the experiments of Prof. J. Lawrence Smith, detailed in *Silliman's Journal*, Vol. xix, fol. 340, 2d series, in which he found that a piece of lime, less than ½-in. in diameter, in the flame of the oxyhydrogen blowpipe, had, when viewed in a clear evening, at the distance of half a mile, an apparent diameter twice that of the full moon, show conclusively that no reliance can be placed upon calculations founded upon the apparent diameter of bodies in a state of incandescence.

10. The apparent form of the meteor—that of a cone moving base

foremost—may have been due to its great angular velocity, combined with the effect of irradiation above referred to. The impression made upon the eye by the incandescent body itself, would doubtless be greater than that made by the sphere of light surrounding it. Consequently we should continue to see the body itself after the impression of the mere glare had faded away; so that the apparent diameter of the end of the tail may represent the actual angular diameter of the body.

11. The invisibility of the meteor to persons at Philadelphia and vicinity, was no doubt due to the position of the sun, the direction of which there coincided with that of the meteor.

Philadelphia, February, 1860.

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*Facts Relating to the Use of Zinc Abroad.**

The reputation of zinc for roofing is not good in England. Abroad the material appears to be used very largely and successfully. To ascertain the reason for this difference the Vieille Montagne Zinc Mining Company have recently commissioned Mr. James Edmeston to inquire into the matter. His report, which was read at the Institute on Monday evening last, and is about to be published, is now before us. The Vieille Montagne Company is a very extensive undertaking:—

"In the seven large smelting establishments in Belgium and Prussia, comprising 230 furnaces, 29,000 tons of spelter are produced, and 23,000 tons of sheet zinc are annually made, besides about 7000 tons rolled at mills which are not the property of the company. In the three establishments for making oxide of zinc, about 6000 tons of oxide are annually manufactured. The company is besides a large purchaser of spelter in the market.

"It is said that the general consumption of spelter throughout the world is about 67,000 tons per annum, of which about 45,000 tons are made to take the shape of rolled sheets, and these are estimated to be applied as follows, each quantity being somewhat below the truth:—

the truth:—	Tons.		Tons.
Roofing and architectural purposes,	23,000	Domestic utensils,	12,000
Ship sheathing,	3,500	Stamped ornaments,	1,500
Lining packing-cases,	2,500	Miscellaneous,	1,500
			44,000

Fifteen years ago the quantity used for roofing did not exceed 5000 tons: none was employed for ship sheathing or lining packing-cases, and the stamped ornaments in zinc date only from 1852."

The process of manufacture is simple: the calamine (carbonate of zinc) is first calcined, by which it loses about 20 per cent. of its quantity: it is then ground in a mill and mixed to the extent of one-third of its bulk with powdered coal, to assist the smelting. The whole being much moistened, this mixture is put into the smelting-pots, and these at six o'clock every morning are placed in the furnaces. At six o'clock in the evening, that is, in twelve hours, the smelting is complete. The metal is drawn out and run into metal moulds: it then goes into the rolling-house, and is again melted and re-cast in a metal mould to produce ingots of the proper size and weight for the required gauge of sheets to be rolled: this second melting is also desirable to obtain proper purity.

In the first place, purity in the metal to be used for building purposes is important: if there be much impurity no after-care will be of any avail. For ship sheathing—and zinc is now very largely used for this—perfect purity is essential, for it becomes immersed in a down-

*From the London Builder, No. 884.

right galvanic bath; and if iron be present in even a small quantity, or lead, it would quickly destroy itself. This is not so much the case in roofs, but purity is most desirable; and impurity may exist to an extent sufficient to spoil the best-constructed roofs, and in many cases has done so beyond doubt.

Mr. Edmeston made inquiries in England previous to going abroad, and all the replies were condemnatory, with two exceptions.

"Some instances of failure were brought before me, and these were mostly as follows:

"Crumbling to pieces; black spots appearing, supposed to be the effect of London atmosphere; holes and wearing out of the metal in a short time;—all these would arise from impurity in the metal, or from contact with iron. Then,

"Cracking in places; soldered joints parting; drips or joints failing in flats; tendency to buckle and to have an untidy appearance in consequence, and general unsoundness of the work;—all these would arise from bad construction."

Abroad, amongst the failures, he mentions one:—

"But, even if the zinc contains no iron, the contact of iron, where a little confined damp may exist, will be quite as injurious. I cannot find that this is understood here: iron nails are commonly used for boarding under the zinc, and if a nail head is in contact, and there is damp, in three months a hole will be eaten through. Generally speaking, for the best roofs on the Continent, zinc nails are used for the boarding, and all iron work, where necessary, and if used at all, is galvanized. Or where iron nails are used for boarding they have small heads, and are hammered well into the wood so as to be buried, and a little cement or stopping is frequently rubbed in over them. Practice has found that the nails thus used rarely do any mischief, and as the zinc nails require certain care and take more time, and are dearer than the iron, I found that in Paris, at all events, the iron were used frequently, but always with the above precautions.

"I could not discover that the contact of lead was injurious, but it is considered to be better avoided.

"Impure zinc being brittle will crack when turned up against the rolls, or it will break off entirely, and the builder who saves something in first cost, is quite likely to lose more in the end from waste.

"The second set of defects to which I have alluded, and other modifications of them, will be referable to ignorant construction: they none of them exist where proper knowledge has been exercised in this respect, and the one object to be kept in view is to permit *perfect freedom to the sheets*, to confine them no where, and to separate lengths of guttering, and any other portions of a roof requiring to be made in long pieces, as much as possible.

"Eaves gutters should be made in short lengths, bent in the direction of the way in which the sheet has been rolled and soldered; the solder put between the sheets and one sheet lapping over the other; they must not of course be screwed to the rafter's feet—a practice, by the way, which occasions a constant failure in the joints of iron eaves gutters. Wherever a down pipe comes, there should be a stopped end in the gutter, and the gutter should never be continued longer than possible in one piece: where it is laid behind a parapet, as in all the new and magnificent buildings in Paris, a separate piece of flashing will disconnect it wholly from the sheeting on the roof. For guttering, the gauge used should be increased in proportion to length, say No. 14 for 10 feet, No. 15 for 20 feet, and so on up to No. 18. There should be a proper substance in all cases. No. 14 is ample for London; in Germany it is customary to use a less thickness.

"The choir of the cathedral at Cologne is covered with Silesian zinc. The old lead was defective and was removed, and the zinc substituted by Herr Zwirner, in 1829. The gutters are zinc: it is laid in the old way without wooden rolls or fillets, as is the custom still in Germany. Herr Zwirner, the architect to the Royal Commission, informs me 'that zinc is now commonly used for roofs in the whole of Germany,' and that all his practice has taught him 'the solidness and closeness of a well-constructed zinc roof.'

"Oak boarding will spoil the zinc, and the fir should be dry; the boards laid with an aperture of about half an inch between each; if they are damp, as much oxidation will take place on the underside of the zinc as on the top of it.

"A good way of laying flats in some situations is without rolls, but with sunk gutters between the sheets, with, in fact, inverted rolls, which form gutters; for London, however, I would recommend the ordinary way, as the small gutters are liable to be filled

with blacks and soot if neglected. In forming laps care must be taken to prevent the water from ascending, by capillary attraction; there must either be space enough to prevent the drops thus rising, or the end of one sheet must touch altogether, and that of the other be kept well away; and this is found the best mode, and the least open to careless treatment by workmen.

"The thicker the zinc, the less its expansion and contraction. And I find as follows, in a report made to the Academy of Sciences, by the director of the Conservatoire des Arts et Métiers, a government institution existing in the Rue St. Martin, to inquire into scientific inventions, civil engineering, and all constructive science:—

"'It appears from actual experiment, that the oxidation proceeds for about four years, gradually diminishing after the first three months, and that it then hardens into a protecting coat ('émail') of a dark grey color, preserving the metal beneath from any further deterioration.' And it concludes by saying, 'that it becomes evident that as a sheet of zinc exposed to the atmosphere for a series of years loses little or nothing of its weight or thickness, and as its surface remains hard and polished, like enamel, it may be fairly deduced that the following years are not likely to occasion any alteration, and therefore that zinc will be placed in the same condition as bronze, which is protected by its 'pattine' for ages.'"

Amongst new works in Paris, Mr. Edmeston mentions—

"The new markets, constructed of iron, under the direction of M. Baltard, architect, in 1856. These great roofs are covered wholly with zinc, No. 14 gauge, the gutters being No. 16, the whole in perfect condition, except in one place, where some undulation has occurred in consequence of the workmen having confined the metal by solder very needlessly, because a little extra labor was necessary to lay the zinc properly: the down pipes are of zinc No. 14.

"Also the entire roofs of the magnificent houses forming the Boulevard de Sebastopol, the new mansions in the Champs Elysées, the new part of the Louvre, in which the flats of the zinc and the curbs only of slate; the roof of the Hôtel de Villa; the roof of the Church of St. Clothilde; and, in fact, nearly every roof formed in Paris within the last fifteen years."

He mentions,—

"That while cement does no injury to the zinc, the lime of Paris destroys it, and that when cisterns or other zinc constructions are confined with brick-work, in mortar, the custom is to fill in round them with earth so as to protect the zinc from the lime."

A report of a committee, appointed by the Central Society of Architects in Paris, recommends,—

"That zinc, which was at first rejected, but is now so generally used, should be applied with great care, as certain precautions, very simple, but never to be overlooked, are indispensable: thus contact with plaster, which contains a destructive salt, is to be avoided; also contact with iron, which is very injurious, and liable to cause a rapid oxidization: eaves gutters should always be supported by galvanized brackets, and no gutter or sheet zinc should be laid on oak boards.'

Mr. Edmeston deduces from these facts and independent inquiries, that it is impossible longer to contend—

"That zinc is other than a valuable and excellent material for building purposes, too important to be overlooked, and worthy of a more extended use and of a better appreciation than it has yet received with us."

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*Experiments on the Strength of Cast Iron Girders.** By J. G. Lynde, M. I. C. E., F. G. S.

The following paper was read at the Manchester Literary and Philosophical Society, Nov. 1, 1859.

The beams experimented on were eighty-nine in number, and were cast by Mr. Mabon, at the Ardwick Iron Works, Manchester, from iron of the following descriptions:—

* From the Mechanics' Magazine, Dec., 1859.

One charge of the cupola consisted of

12 cwt. Goldendale, Staffordshire.
12 " Lane End.
12 " Ormesby, Yorkshire.
12 " Blair, Scotch.
12 " Calder, "
All No. 3 hot blast iron.
12 " Scrap.

The beams were cast on their sides, and were a very good sample of workmanship.

The section of each beam was of the form recommended by Professor Hodgkinson, and upon which his formulæ were based; the total depth of the beam in the centre was 24¼ inches, and at the ends 20 inches; the bottom flanch was 15 inches wide, and 2¼ inches thick; the vertical part of the beam was 1½ inch thick; and the top flanch was 4⅛ ins. wide, and 1½ ins. thick; the total length of the beam was 34 feet 6 inches, and the distance between the supports was 30 feet 9 inches; the weight of the beam was 3 tons 8 cwt. 1 qr.

One of the beams was tested up to the breaking weight with the following results:—

With a load in the centre of—

Tons.	Cwt.		Inch.
31	8	the deflection was . . .	·87.
42	16	"	2·00.
46	12	" . . .	2·25.
50	8	"	2·56.
54	4	" . . .	2·70.
58	0	the beam broke,	

the ends springing back from each other 2 feet 3 inches, the fracture indicating a good sound casting.

There was no permanent set observable in any of the experiments, until the breaking weight was applied, the beam being allowed to recover itself on the removal of the load in each case.

Each of the remaining beams was tested with a load of 20 tons in the centre, the deflection varying from ⅝ to ⅞ of an inch.

The calculations for the strength were based on the following formulæ, given by Professor Hodgkinson in his "Experimental Researches on the Strength and Properties of Cast Iron:"—

First formula, art. 146:

Let w=the breaking weight in tons placed on the centre of the beam,

a=the area of the bottom flanch in inches,

d=the total depth of the beam in inches,

l=the length between the supports in feet,

$$\text{then } w = \frac{2{\cdot}166\, a\, d}{l}$$

In this case $a = 36{\cdot}$
$d = 24{\cdot}25,$
$l = 30{\cdot}75,$

which gives 60·09 tons as the breaking weight of the beam.

The second formula, art. 147, takes into account the thickness of the vertical part of the beam, and is as follows:—

Let W = the breaking weight in tons placed on the centre of the beam,

l = the length between the supports in feet,

b = the breadth of the bottom flanch in inches,

b' = the thickness of the vertical part in inches,

d = the whole depth in inches,

d' = the depth from the top of the beam to the upper side of the bottom flanch in inches,

$$\text{then } W = \frac{2}{3\,d\,l}\left(bd^3 - (b-b')\,d'^3\right).$$

In this case

$$l = 30{\cdot}75,\quad b = 15{\cdot}\quad b' = 1{\cdot}5,\quad d = 24{\cdot}25,\quad d' = 22{\cdot}03,$$

which gives 62·19 tons as the breaking weight of the beam.

The actual breaking weight being 58 tons, it would appear that the constant co-efficient assumed is in each instance too high for the quality of iron of which these beams were cast. This result appears to have been anticipated by Professor Hodgkinson in the case of large beams; and in one of his experiments, art. 147, on a beam cast for Messrs. Marshall and Co., of Leeds, he gives ·625 as the co-efficient, which agrees with the result of this experiment.

Applying this co-efficient to Professor Hodgkinson's formulæ, they will be as follows:—

$$\text{First formula, } W = \frac{2{\cdot}05\,ad}{l}$$

$$\text{Second formula, } W = \frac{{\cdot}625}{d\,l}\left(d\,b^3 - (b-b')\,d'^3\right).$$

The first of these would give 58·2 tons, and the second 58·31 tons, as the breaking weight; either of which calculations would be sufficiently correct for any practical purpose.

Claim to the Invention of Hunt's Steam Boiler.

To the Editor of the Journal of the Franklin Institute.

SIR:—In the *London Engineer* of Nov. 30, and in a recent number of the *Practical Mechanic's Magazine*, will be seen a description and cut of a boiler patented Feb. 14, 1859, by Mr. Thomas Hunt, of Crewe, England, which is substantially the same as that patented and put in use by Capt. R. F. Loper, of this city. The *Patent Office Report* for 1849, and the *Journal of the Franklin Institute* of same year, Vol. XVIII, Third Series, contain the specification and claim, which are:

"The object of my invention is, so to construct a boiler as to cause the products of combustion from the furnace or furnaces to divide into two parts, and again commingle

alternately through a series of labyrinth flues, against the sides of which they are caused to impinge many times in the course of their passage through the boiler."

A modification of this plan is had by placing a series of vertical tubes in the flues.

Claim.—"What I claim as new, is constructing the boiler in the manner described, by the employment of a series of central and side water tables, forming a flue in which the gases are alternately divided and commingled, in the manner and for the purpose set forth."

Shortly after the issuing of the patent, two boilers were built upon his plan, for Capt. Loper, at the works of Messrs. Reaney, Neafie & Co., from drawings made by the writer, and placed one on board the steam barge *Hector*, and the other on the tug *Charles H. Haswell*, where they are still in use from present accounts, and giving satisfaction. The latter boat has two cylinders of 12 ins. bore, 12 ins. stroke; carrying steam for half-stroke, and making about 100 revolutions per minute. The boiler of this boat was the first made. The dimensions are not remembered, but it is quite small; nevertheless, the flues are of sufficient size to admit of access for cleaning and repairs.

The *Hector* has one cylinder 18 ins. diameter, 24 ins. stroke, carrying steam for half-stroke, and making 75 to 80 revolutions per minute. Her boiler is 12 ft. long, 6 ft. 6 ins. wide and high; furnace 3 ft. 6 ins. long, by 5 ft. 6 ins. wide in the clear. The balance of the boiler contains the flues and water legs, thus: The water leg forming the back of the furnace, is 6 ins. in clear, and has an opening in the middle, rising from grate bars to crown of furnace, of 18 ins.; then comes the flue about 13 ins. in clear; then a water leg of 5½ ins. in clear, with a flue on each side between it and the sides of the boiler, of 10 ins. wide, and extending from water bottom to crown; then a flue of 13 ins. again succeeded by water legs of 5 ins. in clear, extending from the sides towards each other, with a passage of 15 ins. between them, and so on; the water legs diminishing by half inches as they approached the back end of the boiler; but the flues are made of the same size to permit of access.

In addition, a row of return flues about 5½ ins. in diameter, was placed above the water legs in order to determine the efficiency of the boiler with an increased amount of surface, compared with that in the *C. H. Haswell*, in which the temperature of the escaping gases was considered to be too high; the small size of the boiler compelling a sacrifice of heat-absorbing surface, in order to get flues of such a size as would afford a passage through them for examination and cleaning. As expected, a gain resulted from the addition of flues. The uptake was not in danger of being overheated by hard firing, whilst it proved that the boiler could be shortened, thus saving valuable freighting-space. The Patentee did not strongly advocate the introduction of the original form, his preferences being for that with the vertical tubes in the flues; hence, it was not placed upon any other boats than those named, whilst the modified type was put upon several steam barges plying between Philadelphia and New York, where it proved to be both economical and efficient.

This claim is not intended to detract from the merit of Mr. Hunt, as an inventor, as he no doubt is not aware of his having been anticipated; but simply to show that the priority of design and introduction to active use, belong to Capt. Loper. J.

For the Journal of the Franklin Institute.

Proposed remedial alterations of, and additions to, the present Law regulating the grant of Letters Patent for Designs.

By H. Howson.

By the third section of an Act approved August 29th, 1842, "in addition to an Act to promote the Progress of Science and the Useful Arts, and to repeal all acts and parts of acts heretofore made for that purpose," a new class of objects, for which no protection had been previously afforded by legislative enactments, was made the subject of Letters Patent, the duration of which is for seven years; the fees being fifteen dollars.

These patents are for new and original designs applied to any manufacture, whether of metal or other material, the act taking no cognizance of any peculiar advantages or utility which the object may possess, or of any process or art by which the form or ornamentation of the object is produced.

The ornamental articles of manufacture which would form appropriate subjects for this class of patents, are so numerous that it would be a difficult matter to classify them, and yet how few manufacturers of such articles avail themselves of a law which was evidently enacted for their especial benefit! How few instances of new ornamental fabrics, new styles of jewelry, or other objects, the merits of which depend, for the most part, on their ornamentation and pattern, are to be found in the list of patents for designs!

It cannot be supposed that the manufacturers of such articles have no desire to maintain a brief monopoly of their productions and a protection against copies and imitations of their wares by rival manufacturers.

How is it, then, that they so seldom avail themselves of the protection which the Act of 1842 is presumed to afford?

The cause of this cannot be attributed to any indifference or neglect on the part of the manufacturers, but to some radical defect in the law.

A lengthened experience as a Patent attorney has convinced the writer that such is the case; and that the defects are a source of general complaint, and that the law is generally unpopular.

The Act has been declared to be ambiguous by more than one good legal authority, and its ambiguity has been frequently admitted by the authorities of the Patent Office.

The defects of the Act regulating the grant of Letters Patent for designs may be classed under two general heads.

First, the duration of the patent and the amount of fees are the same for every ornamental article of manufacture, and this, it is believed, is the main imperfection of the law.

Secondly. The law affords a very doubtful protection against infringers on a patented design.

It is proposed to devote the present paper to the discussion of the defects arising from the uniformity in the charges for and the duration of the time of patents for designs, and to suggestions as to the most appropriate remedies, leaving the inquiries as to the insecurity of this class of patents for a future communication.

It is contended that for some ornamental articles, a patent of seven years' duration is too short, and for other articles too long.

In order to demonstrate this clearly, it will be necessary to discuss the subject in reference to two objects of a very different nature.

A design for an ornamental stove and a fabric of a new and ornamental pattern, will be appropriate selections for this purpose.

Under the present law, the patent will endure for seven years and the fee will be fifteen dollars in both cases.

Now, in getting up a new design for a stove, the manufacturer must, in the first place, be possessed of a well cultivated taste, a readiness for producing figures and ornaments of pleasing effect.

In the second place, he must be in possessoin of the requisite capital to meet the expenses.

In preparing a new design for a stove, it is necessary to make three or four sizes; the patterns for these cost one, two, or even three thousand dollars, according to the nature and extent of the ornamentation.

Is there any just reason why a new and original ornamental manufacture which requires such an outlay as this, which demands no small amount of taste and artistic skill, should be protected by a patent of only seven years' duration, while trifling mechanical devices, many of them of doubtful merit, requiring but little outlay, and the exercise of very limited inventive faculties, are protected by a patent of fourteen years' duration?

It may be argued that in one case the object relates to ornaments of no intrinsic value; whereas the object in the other case is for the accomplishment of some useful end, and that one object is, therefore, a more appropriate subject for legislative protection than the other.

This would be a very contracted view of the matter.

It is true that the production of an original ornamental design and the invention of a new machine, art, or composition of matter, require different mental capacities, but both are of equal value to a civilized community.

Ingenuity and art go hand in hand together; both have an equal demand on the fostering care of the government; as much, and perhaps more, time and labor are expended in the production of ornamental articles of manufacture which are fit subjects for patents for designs, as in the construction of appliances which can be protected by the ordinary class of patents. Why then should the laws make an invidious distinction between the inventor and the artist? Why should the laws say to the designer of jewelry, "You can have a seven years' patent for your design for a bracelet," and to the inventor, "You can

have a fourteen years' patent for your device which forms the fastening for the same bracelet."

It is an anomalous law which restricts the duration of a patent for a design to seven years, because it is a superfluous ornament, and protects the fastening, on the ground that it is a mechanical device for securing the same superfluous ornament. There can be no just reason why the designer should not be allowed to protect his production for the same length of time as the inventor.

The framers of the Act of 1842 had, doubtless, no intention of legislating to the injury of the artist; they may have been actuated by every desire to encourage art in deciding upon the reduced term for the duration of this class of patents and the reduced fees, thinking that it would meet the wishes and requirements of the designers themselves.

They appear, however, to have lost sight of the fact that the law must have an unequal bearing on the producers of different ornamental articles.

To return to the manufacture of ornamental stoves. It has been already remarked that the preparation of the patterns is a most costly matter; so great is the original outlay that every stove manufacturer would be glad to secure his design for double the length of time at present allowed, by the payment of additional fees.

It is well known that small manufacturers, men with neither taste, enterprise, nor capital, are in the habit of waiting for the expiration of a patent of a popular and elaborately carved stove, and after this expiration, of purchasing a stove, using the plates for patterns, and furnishing them to the public to the injury of the original producers.

If a stove will retain its popularity for twelve or fourteen years, who should reap the benefit of that popularity? Surely not the piratical foundryman, who not only makes a fac-simile of the stove, but actually uses the plates for patterns; but the original designer or producer, the man who can command the necessary artistic talent, the capital to turn that talent to account, and the business tact and enterprise which enable him to furnish the public with a highly ornamental article of utility, at a comparatively small cost.

An extended intercourse with stove manufacturers enables the writer to assert that quite as many patents would be obtained for designs for stoves at a charge of $30 government fee, as are now procured at a cost of $15; provided the duration of the patent could be increased in proportion.

If the duration of a patent for a design, however, be fixed at fourteen years and the fees at $30, the law, while it worked to the advantage of stove manufacturers, would bear injuriously and unjustly on manufacturers of other ornamental articles.

The producer of the ornamental fabric would deem it a great hardship if he was compelled to pay $30 for the protection of a design which would, most probably, be out of fashion in two or three years.

For a class of ornamental articles, the sale of which depends on the caprices of fashion, the duration of the patent as at present fixed by law (seven years) is too long, and the fees ($15) too large.

It is, for the most part, the amount of fees demanded which has hitherto prevented manufacturers of an extensive class of ornamental goods from availing themselves of the protection which the present law affords.

Could the manufacturer of the ornamental fabrics obtain a patent for three years by paying a government fee of $5, $6, or $7, there can be no doubt that numbers would avail themselves of an opportunity which they had hitherto neglected on the ground of economy.

It appears to the writer, that a very simple alteration of that part of the law which regulates the duration of time and the amount of fees for patents for designs would meet the exigencies of all manufacturers of ornamental articles.

The proposed alteration is, to establish three classes of patents, as follows:

First class,	duration	14 years,	fee, $30·00
Second "	"	7 "	" 15·00
Third "	"	3½ "	" 8·00

Then will arise the question—"who shall have the power of classifying the different ornamental articles which form the application of patents for designs?"

Not the authorities of the Patent Office, for this would be too arbitrary a measure, and one which would give rise to tedious and expensive correspondence between the applicants and the Office, and would be a certain source of much dissatisfaction.

Let the producers or applicants themselves select the class under which they desire the patent to be granted.

This is a power which may be safely entrusted into their hands.

The stove manufacturer will deem it to his interest to select the first class; the designer of a bust of some popular character, thinking that his production will retain its popularity for seven years, might select the second class.

The weaver, and wall-paper manufacturer, owing to the sudden changes in the fashion of their productions, would doubtless select a patent of the third class.

After the patent has been granted for the time selected by the applicant, he should be allowed no extension of this time; he should have no right to transfer his patent of the third class to that of the second or first class, by the payment of additional fees; should such a course be allowed, it would certainly give rise to much extra labor in the Patent Office, much confusion and constant litigation.

If an applicant has selected for his production a three years' patent, and subsequently discovers that the design patented will retain its popularity for a longer period than he expected, no fault could be found with the law, as it afforded him an opportunity of selecting a longer term; the blame rests with himself, and his own want of foresight.

The law, too, should compel the patentee to mark the article patented, not only with the date of the patent, but with the class under

which it has been issued, so that the public may be aware of its true nature and extent.

Should such modifications be established, it would be but an act of justice to introduce a provision by which the holders of unexpired patents for designs granted under the old law, might, by the payment of the extra fees, have their patents extended to fourteen years from the date of the original grant.

Whenever any sweeping modification in the law regulating the grant of Letters Patent is contemplated, there are three points to be considered in connexion with the proposed alterations.

First. How will it affect the public?

Secondly. What effect will it have on the manufacturer? and

Thirdly. Will it tend to increase or diminish the revenues of the Patent Office?

What effect will the alterations suggested above, have as regards the interests of the general public?

A manufacturer of ornamental articles, whose productions can be protected at a trifling cost, will have some inducement for calling into play superior skill, and a higher class of art, knowing that the monopoly will prove an ample re-payment for the outlay and exertion; the rival manufacturer will endeavor to outstrip his neighbor in producing articles of a superior and more attractive design.

Thus would the demand for labor be increased, the cultivation of the higher branches of art be stimulated, and the restless demands of the public for constant changes in all ornamental articles be satisfied.

It will be needless to remark, that the manufacturers and producers must be benefited by the above alterations; the benefit being especially felt by the manufacturers of stoves and other metal ornaments;—smaller manufacturers of this class of articles will, no doubt, continue to use as patterns the castings from the original design, even after the expiration of a patent of fourteen years.

But the alteration will, at least, allow the original designer to effect sales sufficient to repay him for the outlay before the piratical foundryman can deprive him of his monopoly.

What effect will the proposed alterations have on the revenues of the Patent Office?

As many, or perhaps, more patents for designs for stoves would be granted under fees of $30, as have hitherto been issued under fees of $15, so that the revenue arising from this class of ornamental articles would be at least doubled, without the demand of any extra labor on the part of the Patent Office clerks.

Then the alterations would open a channel for a further revenue arising from patents of the second and third class.

It is impossible to estimate the probable number of applications of the third class of patents, but it is very certain that as soon as the producers became aware of the facilities which the law afforded for protecting their productions at a trifling cost, the number of applications would be very large, and the revenue proportionately increased.

It is true that an extra number of clerks might be necessary to attend to this influx of patents of the third class, but the salaries of these additional clerks would be but a fraction of the revenue derived from the additional fees resulting from the alterations suggested above.

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*On Phosphorescence, Fluorescence, &c.** By Prof. FARADAY.

The agent understood by the word "light," presents phenomena so varied in kind, and is excited to sensible action by such different causes, acting apparently by methods differing greatly in their physical nature, that it excites the hopes of the philosopher much in relation to the connexion which exists between all the physical forces, and the expectation that that connexion may be greatly developed by its means. This consideration, with the great advance in the experimental part of the subject which has recently been made by E. Becquerel, were the determining causes of the production of this subject before the Members of the Royal Institution on the present occasion. The well-known effect of light in radiating from a centre, and rendering bodies visible which are not so of themselves, as long as the emission of rays was continual—the general nature of the undulatory view, and the fact that the mathematical theory of these assumed undulations was the same with that of the undulation of sound, and of any undulations occurring in elastic bodies, were referred to as a starting position.—Limited to this effect of light it was observed that the illuminated body was luminous only whilst receiving the rays or undulations. But superadded occasionally to this effect is one known as *phosphorescence*, which is especially evident when the sun is employed as the source of light. Thus, if a calcined oyster-shell, a piece of white paper, or even the hand, be exposed to the sun's rays, and then instantly placed before the eyes in a perfectly dark room, they are seen to be visible *after* the light has ceased to fall on them. There is a further philosophical difference, which may be thus stated; if a piece of white oyster-shell be placed in the spectrum rays issuing from a prism, the parts will, as to illumination, appear red, or green, or blue, as they come under the red, green, or blue rays; whereas if the phosphorescent effect be observed, *i. e.* that effect remaining after the illuminating rays are gone, the light will either be white, or of a tint not depending upon the color of the ray producing it, but upon the nature of the substance itself, and the same for all the rays. The ray which comes to the eye in an ordinary case of visibility, may be considered as that which, emanating from the luminous body, has impinged upon the substance seen, and has been deflected into a new course, namely, towards the eye; it may be considered as the same ray, both before and after it has met with the visible body. But the light of phosphorescence cannot be so considered, inasmuch as *time* is introduced; for the body is visible for a time sensibly after it has been illuminated, which time in some cases rises up to minutes, and perhaps hours. This condition connects these phosphorescent bodies with those which phosphoresce by heat, as apatite and fluor-spar; for when these are made to glow intensely by a heat

* From the Lond. Athenæum, July, 1859.

far below redness, it is evident that they have acquired a state which has enabled them for a time to become original sources of light, just as the other phosphorescent bodies have by exposure to light acquired a like state. And then again there is this further fact, that as the fluor-spar, which has been heated, does not phosphoresce a second time when re-heated, still it may be restored to its first state by passing the repeated discharge of the electric spark over it, as Pearsall has shown. Then follows on (in the addition of effect to effect) the phenomena of *fluorescence*, and the fine contributions to our knowledge of this part of light by Stokes. If a fluorescent body, as uranium glass, or a solution of sulphate of quinine, or decoction of horse-chestnut bark, are exposed to diffuse day-light, they are illuminated, not merely abundantly but peculiarly, for they appear to have a glow of their own; and this glow does not extend to all parts of the bodies, but is limited to the parts where the rays first enter the substances. Some feeble flames, as that of hydrogen, can produce this glow to a considerable degree. If a deep blue glass be held between the body and the rays of the sun, or of the electric lamp, it seems even to increase the effect; not that it does so in reality, but that it stops very many of the luminous rays, yet let the rays producing the effect pass through. By using the solar or electric spectrum, we learn that the most effectual rays are in most cases not the luminous ones, but are in the dark part of the spectrum; and so the fluorescence appears to be a luminous condition of the substance, produced by dark rays which are stopped or consumed in the act of rendering the fluorescent body luminous: so they produce this effect only at the first or entry surface, the passing ray, though the light goes onward, being unable to produce the effect again; and this effect exists only whilst the competent ray is falling on to the body, for it disappears the instant the fluorescent substance is taken out of the light, or the light shut off from it. When E. Becquerel attacked this subject he enlarged it in every direction. First of all, he prepared most powerful phosphori; these being chiefly sulphurets of the alkaline earths, strontia, baryta, lime. By treatment and selection he obtained them so that they would emit a special color: thus, seven different tubes might contain preparations which, exposed to the sun, or diffused day-light, or the electric light, should yield the seven rays of the spectrum. The light emitted generally possessed a lower degree of refrangibility than the ray causing the phosphorescence; but in some instances he was able to raise the refrangible character of the ray emitted to that of the exciting ray. By taking a given preparation, and raising it to different temperatures, he caused it to give out different colored rays by the single action of one common ray; this variation in power returning to a common degree as the temperatures of the phosphori became the same in all. He showed that *time* was occupied in the elevation of the phosphorescent state by the ray; and also that time was concerned in various degrees during the emission of the phosphorescent ray: that this time, which in many cases was long, might be affected, being shortened by the action of heat, and then the brilliancy of the phosphorescence for the shortened time was

increased. He showed the special relation of the different phosphori to the different rays of the spectrum, pointing out where the maximum effect occurred; also that there were the equivalents of dark bands, *i.e.* bands in the spectrum, where little or no phosphorescence was produced. These phosphori were many of them highly fluorescent. Thus, if one of them was exposed to the strong voltaic light, and then placed in the dark, it was seen to be brilliantly luminous, gradually sinking in brightness, and ultimately fading away altogether: but if it were held in the rays beyond the violet end of the spectrum (the more luminous rays being shut off) it was again seen to be beautifully luminous, but that state disappeared the instant it was removed from the ray. Now this is fluorescence, and the same body seemed to be both phosphorescent and fluorescent. Considering this matter, and all the circumstances regarding time, Becquerel was led to believe that these two luminous conditions differed essentially only in the *time* during which the state excited by the exposure to light continued; that a body being really phosphorescent, but whose state fell, instantly, was fluorescent, giving out its light while the exciting ray continued to fall on it, and during that time only; and that a phosphorescent was only a more sluggish body, which continued to shine after the exciting ray was withdrawn. To investigate this point he invented the *phosphoroscope;* an apparatus which may vary in its particular construction, but in which discs or other surfaces illuminated by the sun or an electric lamp might, by revolution, be rapidly placed before the eye in a dark chamber and so be regarded in the shortest possible space of time after the illumination. By such an apparatus Becquerel showed that all the fluorescent bodies were really phosphorescent; but that the emission of light endured only for a very short time. An extensive series of experimental illustrations upon the foregoing points was made with some fine specimens of phosphori, for which the speaker was indebted to M. Becquerel himself. The phosphoroscope employed consisted of a cylinder of wood, one inch in diameter and seven inches long, placed in the angle of a black box with the electric lamp inside, so that three-fourths of the cylinder were external, and in the dark chamber where the audience sat, and one-fourth was within the box, and in the full power of the voltaic light. By proper mechanical arrangements this cylinder could be revolved, and the part which was at one instant within, rapidly brought to the outside, and observed by the audience. As the cylinder could be made to revolve 300 times in a second, and as the twentieth part of a revolution was enough to bring a sufficient portion of the cylinder to the outside, it is evident that a phosphorescent effect which would last only the 1-3000th or even the 1-6000th of a second might be apparent. All escape of light between the moving cylinder and the box was prevented by the use of properly attached black velvet. The cylinder was first supplied with a surface of Becquerel's phosphori. The effect here was, that when by rotation the part illuminated was brought outside the box it was found phosphorescent. If the cylinder continued to rotate it appeared equally luminous all over, and when the rotation ceased, or the

lamp was extinguished, the light gradually sank as the phosphorescence fell. Then a cylinder having a surface of quinine or æsculin was put into the apparatus. Whilst the cylinder was still it was dark outside; but when revolving with moderate velocity it became luminous outside, ceasing to be so the moment the revolution stopped. Here the fluorescence was evidently shown to occupy time: indeed, the full time of a revolution: and taking advantage of that, the self-shining of the body was separated from its illumination within, and the fluorescence made to assume the character of phosphorescence. Another cylinder was covered with crystals of nitrate of uranium, a hot saturated solution having been applied over it with a fine brush. The result was beautiful. A moderate degree of revolution brought no light out of the box; but with increased motion it began to appear at the edge. As the rapidity became greater, the light spread over the cylinder, but it could not be carried over the whole of its surface. It issued as a band of light where the moving cylinder left the edge of the box, diminishing in intensity as it went on, and looking like a bright flame, wrapping round half the cylinder. When the direction of revolution was reversed, this flame issued from the other side; and when the motion of the cylinder was stopped, all the phenomena of fluorescence or phosphorescence disappeared at once. The wonderfully rapid manner in which the nitrate of uranium received the action of the light within the box, and threw off its phosphorescence outside, was beautifully shown. The electric light, even when the discharge is in rarified media, or as a feeble brush, emits a great abundance of those rays which produce the phenomena of fluorescence; but then if these rays have to pass through common glass they are cut off, being absorbed and destroyed even when they are not expended in producing fluorescence or phosphorescence. Arrangements can however be made in which the advantageous circumstances can be turned to good account with such bodies as Becquerel's phosphori or uranium glass. If these be enclosed within glass tubes, having platinum wires at the extremities, and which are also exhausted of air and hermetically sealed, then the discharge of a Ruhmkorff coil can be continually sent over the phosphori, and the effects both fluorescent and phosphorescent be beautifully shown. The first or immediate light of the body is often of one color, whilst on the cessation of the discharge the second or deferred light is of another; and many variations of the effects can be produced. In connexion with rarefied media it may be remarked, that some of the tubes by Geissler and others have been observed to have their rarefied atmospheres phosphorescent, glowing with light for a moment or two after the discharge through them was suspended. Since then Becquerel has observed that oxygen is rendered phosphorescent, *i.e.* that it presents a persistent effect of light, when electric discharges are passed through it. I have several times had occasion to observe that a flash of lightning, when seen as a linear discharge, left the luminous trace of its form on the clouds, enduring for a sensible time after the lightning was gone. I strictly verified this fact in June, 1857, recording it in the *Philosophical Magazine*,

and referred it to the phosphorescence of the cloud. I have no doubt that that is the true explanation. Other phenomena, having relation to fluorescence and phosphorescence, as the difference in the light of oxygen and hydrogen exploded in glass globes, or in the air, were referred to, with the expression of strong hopes that Becquerel's additions to that branch of science would greatly explain and extend them.

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*On the Progress of Steam Navigation at Hull.**

By James Oldham, M. Inst. C. E.

For generations past, Hull has been noted for its Greenland and Davis Straits fishery, and for many years this has constituted the chief feature of the port. Within the last two or three years steam has been put into successful requisition to aid the dauntless and hardy mariner in the pursuit of this hazardous calling, and now we have several screw steam ships employed; and although some of them are fitted with comparatively small power, they have proved to be possessed of great advantage in the service, and in some instances satisfactorily to the owners. We have had two descriptions of steam vessels employed in the fishery; the first, the old wooden sailing ships, which had been engaged in the service for some years, but which were afterwards fitted with screw machinery and auxiliary steam power. The second, iron-built ordinary screw steam vessels; but which proved, I believe, almost a total failure: the material of which they were built and the want of strength for such a purpose proving them altogether unfit to contend with the severity of the climate and rough encounters with the bergs and fields of ice, some becoming total wrecks, while others returned bruised and rent, and were with difficulty kept from sinking. A question here arises, how far iron ships are calculated to bear the severe frosts of high latitudes, and whether wooden-built vessels, with all their defects, are not the best adapted for encountering such a climate? The screw steam ship which was first sent from Hull, or any other place, to the fishery as an experiment, was the *Diana*, timber-built, 355 tons and 40 horse-power, high pressure, the property of Messrs. Brown, Atkinson & Co., of Hull. This vessel had been some time engaged in the fishery as a sailing ship; but her spirited owners, thinking an important advantage could be gained, determined upon the adoption of steam power, and at once had the *Diana* fitted up for the spring of 1857 by Messrs. C. and M. Earle, who put in the engines, and made the screw to lift out in case of need. The experiment fully answering their expectations, Messrs. Brown, Atkinson & Co. bought the *Chase*, a fine American built ship of immense strength, and of 558 tons. She was fitted by Messrs. Martin, Samuelson & Co. with condensing engines of 80 horse-power, and dispatched to the fishery in the early part of 1858, and with good results. By the application of steam, ships in this service can now make a voyage first to Greenland, and afterwards to the Davis Straits. In the commencement of this year several ordinary iron screw steamers were dispatched to Greenland,

* From the London Civ. Eng. and Arch. Jour., Dec., 1859.

viz: the *Corkscrew*, *Gertrude*, *Emmeline*, and *Labaun;* the latter only of this class, which is the property of Messrs. Bailey & Leetham, had any success; but in consequence of her great strength and peculiar form, succeeded in a tolerable way; the others were much damaged, and, as I have already remarked, returned in a bad condition. The *Labaun* is 584 tons burthen and 40 horse-power.

The next point of interest connected with the steam ships of the port of Hull refers to alterations made in some of the vessels. The *Emerald Isle*, a paddle timber-built ship of 1835, the property of Messrs. Gee & Co., originally $135\frac{8}{10}$ long, lengthened 35 feet, with a gain of 14 inches draft of water, and an increased capacity for 100 tons dead weight. The *Sultana*, iron screw steam ship of 1855, the property of the same house, originally 150 feet long, lengthened 30 feet, with a gain of 10 inches draft of water, and an increased capacity of about 100 tons. It is interesting to observe that in both cases we have no diminution of speed through the water, and that both vessels are improved as sea boats. Daily experience teaches the advantage gained, in almost every point of view, by ships of great comparative length. The iron steam-ship *Lion*, of Hull, formerly a paddle-boat 249 feet long, but now converted into a screw steamer by her owners, Messrs. Brownlow, Lumsden & Co., under the direction of Mr. Anderson, their engineer, exhibits the great advantage gained by the alteration. Her register tonnage is 690, and the total tonnage 1014. She was formerly fitted with steeple engines of 350 horse-power, and had four boilers, two before and two abaft the engines; but these were substituted for direct action engines of 150 horse-power, and two of her old boilers replaced, and by this alteration a clear length of hold in midships of 23 feet is gained. She required before the conversion 650 tons of coal for a St. Petersburg voyage, and consumed 30 to 40 cwt. per hour; but now 350 tons for the voyage, and a consumption of 20 cwt. per hour. By the change of machinery about 130 tons of dead weight is removed from the ship, and she is now able to carry 400 tons more cargo. Her speed is also improved considerably; before the alteration, when drawing 14 feet, the rate was six knots and a half, but since the change, when drawing even more water, they can steam eight knots. Thus, throughout, a saving in almost all departments of the ship, and other advantages, have been effected by this important change. During the last two years many fine steam ships have been built in Hull, and others are in process of building for English and foreign service by Messrs. Brownlow, Lumsden & Co., Messrs. C. and W. Earle, and Messrs. Martin, Samuelson & Co. The last-named firm are making rapid progress in the building of two large paddle steam ships for the Atlantic Royal Mail Steam Navigation Company, of the following dimensions, power, &c.—

	Feet.
Length between the perpendiculars,	**360**
Beam moulded,	**40**
Depth,	**30**
Tonnage, builder's measure,	**2860**
Nominal horse power,	**800**

clouds at the hours of observation, and four days on which the sky was entirely covered with clouds.

A Comparison of some of the Meteorological Phenomena of February, 1860, *with those of February,* 1859, *and of the same month for nine years, at Philadelphia.*

	Feb. 1860.	Feb. 1859.	Feb. 9 years.
Thermometer.—Highest, . .	70°	63°	70°
" Lowest, . .	1	18	—1
" Daily oscillation,	17·8	13·2	13·2
" Mean daily range,	8·8	6·3	7·3
" Means at 7 A. M.,	27·24	32·70	28·70
" " 2 P. M.,	38·07	40·64	37·92
" " 9 P. M.,	31·69	35·99	32·93
" " for the month,	32·33	36·43	33·18
Barometer.—Highest, . .	30·358 in.	30·229	30·638
" Lowest, . . .	29·099	29·316	29·065
" Mean daily range, .	·209	·230	·215
" Means at 7 A. M., .	29·970	29·900	29·915
" " 2 P. M., .	29·885	29·864	29·867
" " 9 P. M., .	29·918	29·891	29·896
" " for the month,	29·924	29·885	29·892
Rain and melted snow,	2·724 in.	3·569	2·729
Prevailing winds,	N.62°W·298.	N. 43° W. ·241.	N. 68½°W. ·294.

This table shows at a glance the variations of temperature. The *daily oscillation* is seen to be nearly 5° greater than it was last February, and the same amount greater than the average for the last nine years. This daily oscillation is the difference between the highest and lowest degrees of temperature for each day. The average of all these differences for the month gives the number in the table. By the *mean daily range* of the thermometer, is meant the difference between the temperature of one day at the several hours of observation, and that of the day immediately preceding, at the same hours. Thus, if the thermometer at 7 A. M., 2 P. M., and 9 P. M. of the 1st of the month, indicated 11°, 14°, and 7°, and at the same hours on the 2d, 4°, 14½°, and 9°, then the mean daily range for the 2d of the month, would be ascertained by adding the differences at each hour together and dividing the sum by 3, to obtain the average. In this case, it would be $\frac{7+0\cdot5+2}{3} = 3\cdot17°$. This mean daily range being found for each day, the average for the month is found by adding them together and dividing by the number of days in the month.

It will be noticed in the table that the mean daily range of temperature for February last, is considerably greater than for February, 1859, and a degree and a half greater than the average for February for nine years.

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WINTER.—As it is frequently interesting and important to compare the seasons of different years with each other, I have prepared the following table, giving the same particulars for the winter as are given

in the above table for the month of February. The winter for meteorological purposes, includes the months of December, January, and February.

A Comparison of the WINTER *of* 1859–60, *with that of* 1858–9, *and of the same season for nine years, at Philadelphia.*

	Winter, 1859–60.	Winter, 1858–9.	Winter, for 9 years.
Thermometer.—Highest,	71°	63°	71°
" Lowest,	1	—2	—5½
" Daily oscillation,	15·60	12·70	12·40
" Mean daily range,	7·90	6·87	6·92
" Means at 7 A. M.,	28·93	32·41	29·29
" " 2 P. M.,	37·64	40·08	37·46
" " 9 P. M.,	32·18	35·60	32·82
" " for the winter,	32·91	36·03	33·19
Barometer.—Highest,	30·399 in.	30·475	30·704
" Lowest,	29·099	29·206	28 941
" Mean daily range,	·189	·214	·212
" Means at 7 A. M.,	29·960	29·973	29·949
" " 2 P. M.,	29·902	29·931	29·908
" " 9 P. M.,	29·929	29·958	29·932
" for the winter,	29·930	29·954	29·930
Rain and melted snow,	9·535 in.	14·258	9·602
Prevailing winds,	N.68°W.289.	N.57°W.268.	N.63°W.304.

*Decimal Coinage in Great Britain.**

The Commissioners appointed to investigate how far it would be practicable and advisable to introduce the principle of decimal division into the coinage of the United Kingdom, have just issued their report, from which we extract the following:—

"The conclusions at which we have jointly arrived are embodied in the following resolutions:—

1. "That the circumstances under which decimal coinage has been introduced in foreign countries, although affording both instruction and warning to us, differ in many important respects from those which exist in this country, and therefore no safe conclusions for our guidance can be drawn from the example, more or less satisfactory, of other countries.

2. "That there appears to be no approach to unanimity of opinion on the question of the introduction of decimal coinage, in the commercial or other classes of the community.

3. "That it is very difficult to come to any useful conclusions as to the merits of the decimal principle in the abstract.

"Distinct and peculiar difficulties attend each separate form in which it has been proposed to introduce the decimal principle into the coinage of the country. A decimal coinage founded on the penny, necessarily ejects the pound sterling; whilst a decimal coinage founded

*From the Lond. Civ. Eng. and Arch. Journal, July, 1859.

on the pound, must involve all the inconveniences attending the abandonment of the penny.

4. "That although many important advantages would attend a decimal coinage founded on the penny, as compared with the pound and mill scheme, yet that a coinage which necessarily involves the disturbance of the pound sterling would, in the present state of public feeling, be unadvisable, and, in fact, impracticable.

5. "That the pound and mill scheme is the only form in which, under the present state of public feeling in this country on the question, the introduction of the decimal principle into our coinage can be contemplated with any reasonable probability of sufficient support.

6. "That as regards paper calculations, there appears to be a preponderance of advantage on the side of decimal coinage; but the extent of the superiority in that respect may be the subject of much difference of opinion.

7. "That as regards the comparative convenience of our present coinage, and of the pound and mill scheme, for the reckonings of the shop and the market, and for mental calculations generally, the superiority rests with the present system, in consequence principally of the more convenient divisibility of 4, 12, and 20, as compared with 10, and the facility for a successive division by 2, that is, for repeated halving, in correspondence with the natural and necessary tendency to this mode of subdividing all material things, and with the prevalence of binary steps in the division of our weights and measures.

8. "That as regards the comparative convenience of the coins provided by the rival systems, the advantage appears to rest with our present coinage.

9. "That the particular form of decimal coinage proposed as the pound and mill scheme cannot be looked upon as a well-assured or demonstrated improvement on our present coinage, but must rather be considered as an experiment of very doubtful result, accompanied beyond all question by many serious transitional difficulties.

10. "That these difficulties are partly of a moral character arising from the violent disturbance of established usages and habits, especially amongst the uneducated classes, which are the least qualified to comprehend, and the least disposed to acquiesce in, such disturbance of their customary course of acting and thinking; and partly of a mechanical character arising from the non-interchangeability of the old and the new coins.

11. "That the advantages in calculation and account-keeping anticipated from a decimal coinage may, to a great extent, be obtained without any disturbance of our present coinage, by a more extensive adoption of the practice now in use at the National Debt Office, and in the principal assurance offices, viz: of reducing money to decimals, performing the required calculations in decimals, and then restoring the result to the present notation.

12. "That duly weighing the foregoing considerations, it does not appear desirable under existing circumstances, while our weights and measures remain as at present, and so long as the principle on which

their simplification ought to be founded is undetermined, to disturb the established habits of the people with regard to the coins now in use, by a partial attempt to introduce any new principle into the coinage alone."

Astronomical Observations.

From the Lond. Artisan, Dec., 1859.

We are glad to hear that the Russian Naval Department has taken up that wonderful invention of Mr. Piazzi Smyth for making astronomical observations on board a rolling ship, and that the Pulkavo astronomers and mechanicians are engaged in manufacturing a large free-revolving apparatus for observing altitudes of stars at night without the aid of the sea-horizon. We should not be less pleased to hear of our own Government taking some advantage of this beautiful and ingenious contrivance.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, March 15, 1860.

John C. Cresson, President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.
} Present.

The minutes of the last meeting were read and approved.

Donations to the Library were received from the Royal Astronomical Society, the Society of Arts, and the Institute of Actuaries, London; la Société Industrielle de Mulhouse, France; L. A. Huguet-Latour, Esq., Montreal, Ca.; the Board of Water Commissioners, Detroit, Michigan; the Maryland Institute, Baltimore, Maryland; Prof. A. D. Bache, U. S. Coast Survey, Washington City, D. C.; George Rush Smith, Esq., Senate, Penna. Legislature; Messrs. H. P. M. Birkinbine, William H. Jones, Dr. B. H. Coates, and the Mercantile Library Association, Philadelphia.

Donations to the Cabinets were received from Messrs. Jos. H. Warrington, and Chas. H. Lyons, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of February.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (9) were proposed, and the candidates proposed at the last meeting (6) duly elected.

The Board of Managers reported that they have organized for the present year by electing Mr. William Sellers, Chairman, and Messrs.

Isaac S. Williams and James H. Bryson, Curators, and have appointed the following Standing Committees:

On Publications.	*On Instruction.*	*Managers Sinking Fund and Finance.*
John C. Cresson,	John F. Frazer,	Frederick Fraley,
B. H. Bartol,	Frederick Fraley,	Samuel V. Merrick,
J. Vaughan Merrick,	Isaac B. Garrigues,	Evans Rogers,
Fairman Rogers,	Alan Wood,	John F. Frazer,
Washington Jones.	George Erety.	George Erety.

The Actuary reported that the following Standing Committees have organized by electing their chairmen, and appointing their times of meeting.

Committee.	*Chairman.*	*Time of Meeting.*
On Library,	James H. Cresson,	1st Tuesday evening.
" Exhibitions,	John E. Addicks,	1st Thursday "
" Cabinet Models,	John L. Perkins,	2d Monday "
" Meteorology,	J. A. Kirkpatrick,	3d Friday "
" Meetings,	Washington Jones,	Monday previous to 3d Thursday.

The following resolution was offered and referred to the Committee on Meetings:

Resolved, That meetings of the Institute be held on each Thursday evening of the month, except the third, in order to discuss scientific subjects in an informal manner.

Messrs. Bement & Dougherty presented a model of their improved cotter-driller and key-seat cutter, designed for drilling and mortising gib and key-holes in stubs of connecting rods, and cutting out slots or key-seats of any width, from ⅛ to 1½ ins., and of lengths from ½ to 30 ins. Two key-seats can be cut at the same time on opposite sides of the one shaft, and perfectly parallel with each other. The quantity of work done is estimated to be *six* times greater than can be done by any other means. Its operating parts are: Two revolving spindles, carrying drills or cutters, moving in carriages which travel longitudinally by means of an attached nut working upon a screw turning in the bed-piece of the machine. The motion of the screw is reversed to give the carriages a return movement, by means of two steel clutches operated by the stops and catches provided for that purpose, and capable of very nice adjustment. A self-feeding arrangement makes the machine entirely automatic. The work is readily put in place, and held either with one center and a pair of self-centering jaws, or by two self-centering jaws.

Messrs. Bement & Dougherty claim an improvement over the English and Scotch cotter drillers, in the adaptation of the screw-traverse motion, thereby obtaining a uniformity of motion not possessed by the latter, which, with a positive reverse motion and universal adjustment in all the parts, make a more satisfactory machine: crank motion combined with elliptic gear wheels being dispensed with. They also claim an adjustable stop-motion as a highly important feature of the machine. Specimens of the work done were exhibited, and bore witness to the accuracy and beauty of the operations of the driller.

Mr. Thomas E. McNeill exhibited and explained his patent "Hot Air Moistening" Register. Immediately above the vents of the ordinary hot air register, a small tank is inserted in the wall, and filled with water. Dipping into this tank and hanging in front of the air vents, is a net-work of candle wick or other suitable material; the net-work becoming saturated with water, the hot air passing between the meshes, becomes moistened before entering the room. A small tank below receives any surplus which may pass over, which is re-absorbed by the net-work when the water in the upper tank is exhausted. The whole is enclosed in an ornamental frame-work projecting about an inch from the wall.

Mr. Jos. H. Warrington exhibited some articles of Japanese manufacture, and explained their make. Amongst them were:—A wooden bowl, lackered with a material of which the composition and mode of application were jealously concealed. Some copper wire, purchased at the price of 9 cents per pound. A rain coat, made of paper, oiled, to prevent the absorption of moisture. The Exhibitor stated that he had worn this coat as a protection against several heavy rain-storms, and that it answered admirably. The smell of the oil used, is not pleasant, but it is not more objectionable than the materials used in making most other water-proof garments.

Mr. Archibald Wilson gave a highly interesting account and illustration of his mode of lighting gas burners by electricity. A chandelier containing fifty-six burners was lighted several times with entire certainty. A full description of the plan and its capabilities will be published in the next number of this *Journal.*

Mr. F. P. Dimpfel exhibited, through the Committee on Meetings, a curious specimen of composition metal, formed of 52 parts copper, 48 parts spelter. Some experiments were tried lately by Mr. Dimpfel, in order to determine the best mixtures for a metal to answer certain purposes, and the sample submitted was a portion which had cooled in the bottom of the crucible. In breaking it up for re-melting, it was found to be perfectly fibrous in structure, except the outer skin, which was, as usual, granular. The fibres are perpendicular to the surface cooled first; they are sonorous, tough, and elastic, and of a golden yellow color, resembling that of spelter solder, being nearly of the same composition. The endeavor was made to get castings having the same structure, for pump rods; but the trial was not successful, the fibres being transverse instead of longitudinal, probably owing to a disposition to arrange themselves perpendicularly to the cooling surfaces. Experiments are still making under varied conditions, to produce castings with the fibres in a direction coinciding with that of the rupturing forces, but thus far without success.

Mr. D. P. Deiterich sent for the inspection of the members, a Vulcanite Emery-wheel, for cutting, grinding, or polishing. It is composed of prepared india rubber, combined with emery. The latter material is made of any grade required for cutting or for polishing. The vulcanite can be spread in thin sheets on leather, cloth, or paper; or made in solid plates. When used with oil, a dead finish results; when with water, a grindstone finish; or, when dry, a bright polish.

The wheels can be turned off in a lathe running slowly; thus, any desired shape can be given to the grinding surfaces, or they can be trued up, should the surface become uneven or glazed. Wheels of from 12 ins. diameter 2 ins. face, to 1½ ins. diameter ¼-in. face, are made, with intermediate sizes, so that any kind of work, either plain or moulded, can be surfaced by them.

The Committee on Meetings presented to the notice of the members a Hydraulic Instrument, patented by Mr. J. E. Wootten, and designed to supersede the use of the ordinary crowbar, as applied to moving locomotive engines or railroad cars by hand power, an operation technically known as *pinching*.

The instrument is compact, simple in its arrangement, and light, its weight being but 13 lbs.

By its use, the power applied to the lever is multiplied a hundred times, and the accumulated power is applied directly against the periphery of one of the wheels of the engine or car to be moved.

BIBLIOGRAPHICAL NOTICE.

Engineering Precedents, Vol. II, 8 vo. pp. 231. By B. F. Isherwood, U. S. N.: Baillière Brothers, 440 Broadway, N. Y.

The above is the second of the series, the first volume of which has previously been noticed in this *Journal*. Its contents are more varied and numerous; and, in a practical point of view, more valuable to the engineer: embracing the records of experiments to determine the relative efficiency of certain coals, the economic effect due to the expansion of steam, the value of Prosser's and of Ellis' boilers, and the comparative advantages of Horizontal and Vertical Tubular Boilers, together with synopses of the performance of the U. S. Steamers *Niagara* and *Massachusetts*.

The work before us exhibits in a remarkable degree the care and patient research of its author.

The limits of a brief notice on such a work, forbid our entering critically upon all the subjects so interesting to the engineer which have been treated in it. We shall notice only a few of the more striking. The experiments on coals embraced Blackheath anthracite, Trevorton and Cumberland semi-bituminous, burned with and without perforated fire doors; and although from the type of boiler, size of the engine, and other peculiar circumstances, they afford no indication of the *absolute* values of either of the combustibles named; yet there seems no reason to discredit the accuracy of a comparison based upon the results observed; since in all the experiments these circumstances were the same, and the duration long enough to eliminate errors of observation.

The general comparison of evaporative efficiency was found to be as follows:—

	By Weight.	By Bulk.
Blackheath,	1·00	1·00
Trevorton,	1·21	1·07
Cumberland,	1·24	1·20

With air holes in the furnace doors, these results were increased from $2\frac{3}{4}$ to $5\frac{1}{4}$ per cent.

The comparison between the "Horizontal Fire Tube," and "Vertical Water Tube," boilers of the U. S. Steamer *San Jacinto*, has already been published in this *Journal*. It indicates an economical superiority in the latter type under the conditions of the experiments made, when the combustion was necessarily slow, the vessel being moored at the dock. The important question remaining to be decided by accurate experiment is, to what extent, if any, this superiority may be affected by the rapid evaporation required in the boilers of merchant steamers?

We regard the account of experiments made with the Smithery Engine at the New York yard with a view to determine the practical advantages of working steam expansively, and the deductions drawn therefrom, (to whatever extent they may be sound,) as by far the most important part of the book. The author, as we have said, is careful and pains-taking in making and observing his trials; he is also bold in enunciating his ideas and deductions, although they may conflict with theories generally received. It is a little unfortunate that the work done by the engine on which the trials were made, was disproportionately small for it; and although the disadvantages attending this fact were more damaging to the economy of "following long" than of cutting off short, yet, from this cause cavilers may be disposed to dispute Mr. Isherwood's conclusions. It cannot, however, be denied that, in some important particulars, those conclusions are well founded. He shows—

1st. That the economic gain from expansion is very much less than theory indicates.

2d. That leakage of valves plays an important part in the economy of the steam engine when expansion is used; increasing the apparent effect produced by it, and assimilating, to a considerable degree, "throttling" and "cutting off" steam.

The reasons given for assertions so contrary to the ideas generally held by scientific and even by many practical engineers, are cogently stated and deserve an attentive consideration. In the first place, attention is drawn to the losses which occur before steam is admitted into the cylinder, and which therefore are to be subtracted from the entire evaporative efficiency of the combustible before comparisons can be entered into of the effect of various degrees of expansion; these may reduce the theoretical value of the fuel nearly one-half in marine engines; hence any gain from expansion must be referred to this diminished principle; secondly, the losses of steam required to fill clearance and ports relatively increase with greater expansions, because they remain the same while the proportion of the cylinder to be filled is reduced; thirdly, the back pressure, amounting to about 5 pounds in condensing, and at least 15 lbs. in non-condensing engines, is a constant quantity for any point of cutting off; fourthly, the friction of engine, or power required to work it at a proper velocity, is a constant quantity for all degrees of expansion; fifthly, there is a certain condensation *due to the expansion itself* and irrespective of all other considera-

tions, which annihilates a portion of the steam, and this evil becomes greater, the farther expansion is carried out. All these causes combined reduce, to an enormous amount, the theoretical gain due to expansion; and we advise all advocates of that principle to study our author's volume. As a necessary result of his deductions, Mr. Isherwood is no friend to "Patent cut-offs."

As we do not remember to have seen elsewhere a distinct statement of the doctrine above alluded to, that condensation attends expansion as a condition of the case, we shall quote it for the benefit of our readers in the author's own words, in order that this very important subject should receive a thorough "ventilation;" reserving to a future opportunity any comments we may have to make upon it.

"With steam of any given tension, the particles of water are at a certain distance apart and are kept at that distance by the repulsive effect of a certain quantity of heat to which the term "latent" is applied. The effect of this heat being expended entirely in keeping the particles asunder, it is balanced by the mechanical work equal to resisting their approach in consequence of their attraction for each other, hence it cannot be sensible to the thermometer, for it cannot be expended two ways, one in keeping the particles of water apart, and the other in imparting temperature to foreign bodies, as the thermometer. By cutting off the steam from any further accession of heat and simply expanding it, the particles are removed to a further distance apart, and to keep them at this greater distance more latent heat is required; but the supply of heat from fuel being shut off, this additional amount of latent heat cannot be obtained except by the condensation of enough of the steam to liberate so much heat as will maintain the balance of the steam in the form of steam. In other words, the latent heat that was sufficient to keep a given weight of steam of a given tension in the form of steam, being insufficient to maintain that same weight in the form of steam when its particles are removed further apart by expansion, has concentrated its action upon such portion of the steam as it could maintain in that form, and the other portion by this abandonment returns to its original state of water. And here we have the cause of the condensation of steam by expansion *per se*.

"What is called the sensible heat of steam is the heat above what is necessary for keeping the particles asunder in the form of steam, and the use of sensible heat is merely to equilibrate the pressure under which the steam is generated, and will vary with the pressure. If steam were generated *in vacuo* and free from influence from outside temperature surrounding the vessel, it would have no sensible temperature and the total heat would be all latent heat, for on that alone depends the characteristic difference between steam and water, namely, elasticity."

The mechanical execution of the whole work is good, and we feel assured that the labors of its author in the cause of engineering will be the better appreciated as they are more fully known. M.

Abstract of Meteorological Observations for January, 1860; *made in Philadelphia, Adams, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.*

Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.

1860. Jan.	Barometer. Mean.	Barometer. Mean daily range.	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
☽ 1	30·115	·148	10·3	11	11·8	·055	71		N N W.
2	30·245	·130	11·0	13	1·3	·058	65		N W.
3	30·216	·079	16·0	15	5·0	·067	62		S W.
4	30·011	·205	25·8	9	10·5	·129	88	0·185	S W.
5	30·337	·326	15·5	18	10·3	.072	63		N W.
6	30·287	·121	19·2	16	3·7	·085	67		S W.
7	29·924	·364	35·3	22	16·2	·185	81	} 0·718	N E.
○ 8	29 844	·139	35·7	9	5·0	·207	90		N E.
9	30·061	·217	40·3	20	6·0	·176	55		N W.
10	30·014	·046	35·7	9	7·0	·198	90		S W.
11	29·882	·132	42·5	17	6·8	·308	89		S W.
12	30·035	·153	33·0	12	8·2	·141	69	0·663	N W.
13	30·203	·168	31·2	6	2·2	·119	61		W N W
14	29·824	·378	31·8	5	2·0	·162	89	1·219	N.
☾ 15	29·693	·196	34·3	9	2·5	·188	85		S W.
16	29·701	·057	40·7	19	6·3	·220	63		S W.
17	29.644	·094	36·8	9	5·2	·173	69		N W.
18	29.772	·131	34·5	11	2·3	·108	45		(var.)
19	29·851	·119	32·7	10	4·5	·082	42		(var.)
20	29·891	·086	39 3	20	8 7	·153	47		S W.
21	29 761	·181	46·3	28	7·0	·199	41		S S W.
● 22	29·783	·034	47·5	16	4·8	·195	46		W N W
23	30·065	·283	39·2	15	8·3	·126	44		W.
24	30·024	·129	41·7	20	4·5	·151	45		S W.
25	29·788	·237	48·3	15	7·7	·112	24		W.
26	29·920	·144	35·2	15	13·2	·094	38	0·138	(var.)
27	29·835	·086	29·0	9	6·5	·105	62		N W.
28	29·772	·063	31·7	16	4.7	·127	60		S S W.
29	30·043	·272	31 5	14	1·2	·108	50		S W.
30	29·805	·289	44·3	24	12·8	·191	47		S S W.
☽ 31	29·828	·042	39·3	28	6·3	·163	38	0·428	W.
Means	29·941	·159	33·4	15	6·5	·144	61	3·351	N89°W.

Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 feet. Prof. M. Jacobs, Obs.

1860. Jan.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g. winds
	Inch.	Inch.	°	°	Inch.	Direc.
1	29·777	·162	3·7	13.3		N W.
2	29·903	·126	2·3	2·0		N W.
3	29·826	·117	7·7	8·7		S W.
4	29·640	·186	23·3	9·7		(var.)
5	30·027	·389	9·0	15·7		N W.
6	29 905	·153	6·3	6·0		(var.)
7	29·508	·397	25·3	22·0	0·850	S W.
8	29·411	·176	32·3	6·0		S S W.
9	29·686	·280	32·7	3 7		S S W.
10	29·646	·038	35·7	3·7		S.
11	29·443	·208	37·3	5·0	} 0·640	S.
12	29·672	·232	31·3	6 0		(var.)
13	29·844	·172	28·3	4·3	} 0·880	N E.
14	29·401	·443	32 7	4·3		S S W.
15	29·254	·1"0	35·7	3·0		(var.)
16	29·268	·046	38·0	3·0		(var.)
17	29·191	·078	33·3	8·7	0·085	N W.
18	29·343	·153	31·7	4·3		S S W.
19	29·455	·112	28·7	3·0		N W.
20	29·491	·084	34·0	5·3		S.
21	29·337	·154	47·0	13 0		S W.
22	29·410	·073	42·7	3·7		(var.)
23	29·716	·306	35·7	7·0		N.
24	29·584	·156	38·7	6·3		S.
25	29·400	·214	47·3	12 7		(var.)
26	29·454	·149	29·7	17·7	} 0·280	S W.
27	29·423	·098	26·7	3·7		N W.
28	29·355	·106	26·0	6·7		S S W.
29	29·615	·260	26·7	3·3		S.
30	29·385	·230	40·3	13·7		W.
31	29·442	·057	34·3	8·0	0·400	(var.)
Means	29·542	·178	29·3	7·5	3·135	S77°W

Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.

1860. Jan.	Barometer. Mean.	Barometer. Mean daily range.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain and Snow.	Prevail'g winds.
	Inch.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	27·764	·111	1·0	7·0	·043	59		W.
2	27·942	·178	5·3	4·3	·067	81		W.
3	27·853	·148	18·7	13·3	·140	88		W.
4	27·773	·156	21·7	11·0	·153	88	0·316	W.
5	28·011	·238	10·0	11·7	·134	87		W N W
6	27·855	·186	21·0	11·0	·175	89		S W.
7	27·518	·338	40·0	19·0	·248	100	0·326	S.
8	27·571	·112	39·3	3·3	·218	75		W.
9	27·733	·162	37·0	4·3	·211	72		S.
10	27·701	·032	47·7	10·7	·282	67		S W.
11	27·600	·129	42·0	9·0	·311	92	0·514	(var.)
12	27·757	·153	27·3	14·7	·144	63		(var.)
13	27·836	·079	24·7	8·0	·168	94	} 0·795	S.
14	27·463	·373	35·3	10·7	·220	100		S.
15	27·400	·099	31·3	4·0	·168	89		W.
16	27·442	·042	37·7	6·3	·202	72		W.
17	27·376	·066	31·3	6·3	·142	69		W.
18	27·410	·049	27·0	5·0	·161	89		(var.)
19	27·604	·194	25·7	2·0	·147	78		W.
20	27·647	·043	38·7	13·0	·238	77		S W.
21	27·552	·094	46·0	7·3	·269	67		W.
22	27 602	·071	39·0	7·0	·212	63		W.
23	27·847	·245	33·3	5·7	·195	68		(var.)
24	27·725	·122	44·7	11·3	·275	65		S W.
25	27·669	·103	41·0	17·0	·204	68	0 026	W N W
26	27·589	·159	28·0	13·0	·167	100	0·476	(var.)
27	27·571	·089	26·7	5·3	·153	88		W.
28	27·453	·184	25·0	1·8	·175	94	0·226	W.
29	27·649	·259	28·3	14·7	·124	40		S W.
30	27·530	·128	39·7	14·0	·150	52		W.
31	27·594	·064	29·7	10·7	·211	73		(var.)
Means	27·646	·142	30·5	9·1	·184	78	2·679	S78°W

Abstract of Meteorological Observations for January, 1860; made in Dauphin, Northumberland, Centre, Huntingdon, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860. Jan.	HARRISBURG, Dauphin Co. 40°16′, N. 76°50′, W. Height, 300 ft. JOHN HEISELY, M. D., Observer. Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Prevail'g winds.	SHAMOKIN, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRIEL, Obs. Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.
	Inch.	°	°	Direc.	°	°	Inch.	Direc.
☽ 1	30·068	11·7	8·7	N W.	2·7	11·3		W.
2				N W.	5·0	2·3		W.
3	30·095	15·0		S.	13·0	8·0		W.
4	29·926	24·3	9·3	S.	26·3	13·3		W.
5	30·291	18·7	5·7	W.	11·0	15·3	0·010	W.
6	30·211	15·3	4·7	S E.	11·0	12·0	} 0·546	W.
7	29·767	30·3	15·0	E.	33·7	22·7		E.
○ 8	29·718	34·3	5·3	W.	41·0	7·3		W.
9	29·958	34·0	3·7	S.	38·3	4·0		W.
10	29·900	34·7	2·7	?	43·7	5·3		W.
11	29·726	37·7	3·0	N.	36·3	5·3		E.
12				(var.)	29·0	10·7	0·506	W.
13	30·121	30·3		S W.	32·7	4·3		W.
14	29·682	32·7	2·3	E.	30·7	6·7	0·650	E.
☾ 15	29·502	37·7	5·0	W.	37·3	6·7		E.
16	29·535	37·7	2·7	S.	38·7	8·0		W.
17	29·487	36·0	5·0	(var.)	38·3	7·7		W.
18	29·610	34·0	3·3	S E.	34·3	7·3		W.
19	29·744	31·7	3·7	W.	28·7	13·7	0·060	W.
20	29·757	35·3	4·3	S W.	31·0	11·7		W.
21	29·599	41·7	6·3	S W.	38·7	4·3		W.
● 22	29·662	43·0	3·3	W.	41·3	5·3		W.
23	29·986	39·7	4·7	W.	36·7	10·0		(var.)
24	29·877	37·7	5·3	(var.)	38·3	13·0		W.
25	29·659	46·0	9·0	W.	47·7	13·3		W.
26	29·777	34·3	11·7	(var.)	29·0	15·3	0·300	W.
27	29·698	30·3	4·0	N W.	28·7	5·7		W.
28	29·634	31·3	3·0	(var.)	28·3	3·7		(var.)
29	29·905	31·3	2·7	(var.)	24·7	3·7		W.
30	29·644	42·3	11·0	W.	43·3	16·7		W.
☽ 31	29·728	33·7	6·7	S W.	28·7	14·7	0·060	W.
Means	29·802	32·5	5·8	S 57° W.	30·7	9·3	2·112	S 81° W.

1860. Jan.	FLEMING, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. BRUGGER, Obs. Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevailing winds.	HUNTINGDON, Huntingdon Co. 40°35′ N. 78°3′ W. Height, 734 ft. W. BREWSTER, M. D., Obs. Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.
	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.
☽ 1	3·7	3·3		N W.	29·664	1·0			(var.)
2	6·7	3·0		W.	29·799	3·0	3·3		(var.)
3	12·3	7·7		(var.)	29·637	11·3	8·3		N E.
4	22·3	11·3	0·100	N W.	29·469	25·7	15·7	0·050	S W.
5	9·3	13·0		W.	29·861	12·0	13·7		W.
6	8·0	11·3		(var.)	29·723	7·7	9·0		(var.)
7	26·0	15·0	0·592	(var.)	29·296	27·7	20·0	0·330	N N E.
○ 8	41·0	15·0		N W.	29·265	36·0	9·7		N N E.
9	36·7	4·3		W.	29·477	34·0	3·3		S S E.
10	35·0	1·7		(var.)	29·425	35·0	3·0		N E.
11	36·7	4·3	0·100	S E.	29·276	38·7	7·0	0·250	(var.)
12	27·0	9·7	0·170	W.	29·499	28·3	10·3		(var.)
13	23·0	10·7		W.	29·622	23·7	13·3	0·160	(var.)
14	30·7	7·7	0·310	E.	29·236	32·7	9·0	0·250	S E.
☾ 15	33·3	4·7		N W.	29·074	35·7	3·0		(var.)
16	38·3	5·7		(var.)	29·104	35·0	6·7		(var.)
17	34·7	7·0	0·100	(var.)	29·089	34·3	9·3		(var.)
18	27·7	9·0		(var.)	29·123	32·7	3·7		S W.
19	23·3	9·0		N W.					W.
20	38·7	15·3		W.					
21	47·0	8·3		W.					
● 22	40·7	7·0		(var.)					
23	32·7	8·0		N W.					
24	36·7	6·7		(var.)	29·421	37·7			(var.)
25	42·3	11·0		W.	29·298	46·0	10·3		W.
26	28·7	13·7	0·438	E.	29·413	29·7	16·3	0·300	(var.)
27	24·3	4·3		N W.	29·338	27·3	3·7		N E.
28	27·7	3·3	0·100	N W.	29·205	30·7	3·3		(var.)
29	22·7	3·3		N W.	29·432	20·7	10·7		(var.)
30	36·0	13·3		N W.	29·207	37·3	16·7		(var.)
☽ 31	25·0	11·0	0·150	(var.)	29·312	30·3	7·0	0·250	(var.)
Means	28·3	8·6	2·060	N 59° W.					

1860. Jan.	INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs. Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	TARENTUM, Allegheny Co. 40° 37′ N. 79° 46′ W. Height, 905 feet. J. H. BAIRD, Obs. Thermometer. Mean.	Thermometer. Mean daily range.	Prevailing winds.
	°	°	Inch.	Direc.	°	°	Direc.
☽ 1	—0·3	4·3		S W.	3·3	1·7	W.
2	4·0	4·3		S W.	7·3	4·0	S W.
3	17·7	13·7		S S W.	22·0	14·7	S W.
4	20·7	11·7	0·450	N W.	22·3	12·7	W.
5	5·0	15·0		(var.)	3·3	18·7	?
6	22·7	20·3		S.	17·0	13·3	S W.
7	39·7	17·0	0·500	(var.)	37·3	20·3	?
○ 8	39·7	2·7		S W.	39·0	4·3	S W.
9	38·7	5·0		S E.	37·7	5·3	?
10	47·0	8·3		S.	42·3	4·7	?
11	36·7	13·0	0·480	S W.	37·3	13·0	N W.
12	23·3	13·3	0·160	(var.)	25·3	12·0	S W.
13	29·3	6·7		S E.	28·3	7·0	N E.
14	34·0	4·7	0·320	(var.)	34·0	8·3	(var.)
☾ 15	34·0	2·7		S W.	35·7	1·3	S W.
16	35·7	1·7		S W.	38·3	3·0	S W.
17	31·3	4·3		(var.)	32·0	6·3	W.
18	31·0	1·7		S W.	30·7	2·7	W.
19	25·7	5·3		S W.	26·7	4·0	S W.
20	39·0	18·3		S W.	37·7	11·0	S W.
21	43·7	8·7		S W.	43·3	5·7	S W.
● 22	39·0	4·7		S W.	36·3	7·0	W.
23	28·7	10·3		S W.	31·0	5·3	S W.
24	46·0	17·3		S.	46·0	15·0	S W.
25	37·0	16·3		S W.	39·7	18·3	(var.)
26	25·3	11·7	} 0·390	(var.)	27·0	12·7	N E.
27	22·3	4·3		S W.	25·0	4·7	W.
28	26·3	4·0		(var.)	30·0	5·0	S W.
29	25·7	8·0		S W.	27·7	12·3	(var.)
30	33·3	12·7		S W.	40·0	17·0	S W.
☽ 31	19·0	19·3		(var.)	23·7	16·3	(var.)
Means	29·2	9·2	2·300	S 44° W.	29·9	9·8	S 66° W.

JOURNAL

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CIVIL ENGINEERING.

Translated for the Journal of the Franklin Institute.

The Sewerage of Algiers. By M. Piarron de Mondesir, *Ing. des Ponts et Chaussées.*

(Continued from page 226.)

Man-hole Shafts.—These shafts, which served for the excavation of the tunneling of the branch Bab-Azoun, were, from the beginning, opened the clear width of the galleries with a length of 9·84 ft. measured along the axis of the sewer. It was found to be necessary to line them with masonry throughout their height to preserve and transform them into man-holes.

The cylindrical opening of the masonry of the man-hole shaft preserved the width of the gallery in the clear; its height was variable and its length was always 9·84 feet. The horizontal section presents a rectangle much rounded at the angles, a disposition chosen from simple motives of economy. The upper end is covered by a semi-circular arch, in which is placed a circular trap-door 1·96 ft. in diameter. This trap is closed by an assemblage of cut-stone bedded in the arch, and like those of the simple man-holes, supporting an oak frame and a cast iron frame. The position of the trap varies in each man-hole shaft for different local reasons, but it is always situated directly above the axis of the gallery, so as to utilize the opening in raising or lowering materials without injury to the landing places or the ladders. To effect an easy descent through the man-hole shafts, landing places

of cut-stone were established at different heights, and to them were fastened oak ladders tarred.

The upper landing is placed 4·9 ft. below the level of the revetment arch. It is approached by a small portable ladder. The lower landing is established at nearly half the height between the springing and the key of the main sewer arch. The lower ladder, resting upon the invert of the sewer, is hung upon the screw rings let in upon the lower landing, and may be raised at will by a chain and pulley placed upon the second landing. This disposition makes the access to the sewer through the man-hole shafts as easy as possible. These man-hole shafts are usually accompanied by a water inlet cess-pit, which is connected with it.

Water Inlet Sumphs.—These sumphs being only 1·97 ft. wide,* with depths from 29 to 39 ft., would have presented peculiar difficulties had they been isolated and dug out separately. Their connexion with the man-hole shafts, as might be expected, has greatly facilitated their construction, as it only called for a simple enlargement of the excavation. These sumphs are not only designed to receive the rain water of the grate surmounting them, but they serve for the general issue of all the neighboring sewers. In fact, its great depth did not admit of our multiplying direct branches upon the sewer itself. They have been united by lateral secondary sewers, and directed to the nearest sumph. There are sumphs receiving affluents upon their three sides. By reason of the great mass of water which they receive, and the formidable shocks to which they are exposed on account of their great depth, these sumphs are well provided with cut-stone bottoms and covered with a coating of Vassy cement. The top of each sumph is crowned like the common water inlets.

Different Connections.—It is seldom that each private dwelling is brought in direct communication with the main sewer. We were compelled to construct upon each branch a considerable development of lateral collecting sewers, which receives the drainage of a series of houses and then branches into the main sewer. I would observe that the affluent or lateral branches were always located so as to arrive in an oblique direction. A cut-stone sill, or overfall stone, is always placed at the outlet of an affluent into the sewer.

The terrace spouts were put in communication with the sewer, or its affluents, by means of small canals in masonry, much inclined. A small chimney covered with a flagging serves to cleanse the small conduit when choked up.

Projected Flushing.—It was held as a principle, by the Council General of "Ponts et Chaussées," and by the War Department, that flushing should be practised in the three branches, to operate a general cleansing. This part of the work is only projected. I give a summary account of it, as completing the works pertaining to the sewerage system of Algiers.

A reservoir containing 1757 cubic yards of water is projected under the public square of Chartres. The depth of the water in the reservoir

*An exception is made in the case of the ravine sewer of Tivoli, which has a width of 3·28 ft. and is connected with the man-hole shaft, T 12.

is to be 13 ft. The waste is established at the side, 72 ft. above the mean level of the sea. The reservoir is fed by the waters of the Hamma, that is to say, by the product of the conduits placed in the branch Bab-Azoun. The flushing conduit, whose level is at the level of the invert of the sewer, will be 0·98 ft. in diameter. It will pass through the streets Chartres and Porte-Neuve. Arriving at the right of the Arcades of Government Square, it forks on one side towards the head of the Bab-Azoun branch, and on the other, to that of the branch Bab-el-Oued. Opposite the street Divan, a branch at right angles is directed towards the head of the Marine branch. Gates are disposed so as to turn the water, at will, into either of the three branches.

The plan, as prepared and submitted to the Administration, has not provided galleries for the placing of the flushing pipe between the heads of the three branches. But this would be an ill-judged economy, and the establishment of these galleries would be so advantageous for the general ventilation of the sewer, that a change from the original plan will be proposed for this purpose, and will most probably be accepted. The length of the galleries to be opened between the three heads, will be 636 feet. This length will be reduced to 295 feet, if we limit ourselves to the communication between the heads Bab-Azoun and Bab-el-Oued.

It is readily conceived what a powerful means of ventilation will be gained by thus putting into communication the three branches of the sewer, or at least the two principal ones. We shall have, then, a single canal emptying from its summit into the sea at each end, and a very strong current, which will drive the gas towards it, on either side, according to the direction of the wind.

In note B, will be found calculations and observations relative to the effects of these flushings.

Workmen killed and wounded.—It is well known that subterranean works are dangerous for the workmen. Accidents would increase at every step, unless the greatest precautions were taken, and the most active supervision maintained by the Administration. Fortunately, we had but few accidents to regret, upon the works of the sewer. Two workmen only were killed, five were seriously injured, and seventeen slightly. One of the workmen was a victim to his own awkwardness in falling from the top of the ladder, in a man-hole shaft. Another was the victim of his own imprudence and disobedience of the engineer's order, in using an iron tamping-bar to charge a blast, instead of the prescribed one of copper. The wounds were mostly received in the subterranean galleries of Bab-Azoun. They were generally occasioned by the falling of the rocks. The government generously relieved the principal sufferers from accidents.

I cannot let this opportunity go by without bearing testimony to the unshaken devotion of the laborers employed on the sewerage works. A large number of excavators, miners, and masons, have been upon the work from its commencement to its completion, without refusing any task, however painful or dangerous. I have never seen these men leave their post in time of danger. I would also bear witness to the

good conduct of M. Gay, the Overseer, who supervised the works of the three branches most creditably in all respects.

Archæological Discoveries.—In the execution of the work, there were frequent deep diggings in variable soil. While, in the galleries of the Bab-Azoun, was found the virgin rock, the base of the site of Algiers; in the streets Bab-Azoun, Bab-el-Oued, and Marine, was frequently encountered made ground, and already worked, either by the Moors or Romans.

There was brought to light, in the Marine street, at depths from 13 to 16 ft., an ancient Roman Way, whose walls of hard cut-stone were used for pit-fall stones in the construction of the sewer. The inhabitants of Algiers must have seen a great number of these flags deposited in some of their streets. The rain had cleansed them, and in their worn and polished surfaces might be seen the traces of circulation interrupted many centuries back. Similar flaggings were found, but in less quantities, in the streets Bab-Azoun and Bab-el-Oued.

Upon all points where the ground occupied and traveled by the Romans has been laid bare, has been found a great number of medals. Also, at the extremity of the street Bab-el-Oued near Fort Neuf, were discovered articles of pottery, such as lamps, lachrymals, funeral urns, &c. The relics have been sent to the Museum of Algiers.

Results in a Sanitary point of view.—In its actual state, the harbor, freed from the product of a great majority of the waters which polluted it before, is not as yet thoroughly cleansed. Indeed, some of the constructions adjoining the sea, and especially many houses in the street of Are, in the quarter of the Marine, are found to be too low to turn their waters into the sewer. The port then receives a very small contingence of the filthy and impure water. But when the magnificent projected street, called Rempart, shall be completed, the port will be thoroughly cleansed.

This street will enclose the city on the port side, with a continuous girdle, and will form an upper quay built upon arches, and separated from the quays proper by an enormous breast-wall.

The establishment of this new street will of necessity occasion the disappearance of all the low structures which still empty into the port, and its levels being calculated to deliver all their water in the main sewer through transverse sewers already begun to be built, the harbor will not then receive a single drop of water coming from the city. It will only receive the waters of the islet of the Marine, and of some new quays, a surface for which no account has been taken in my calculations, as once before stated.

Expense.—It remains now to give the amount of expenditure.

The enclosure sewer of Algiers, comprising all the secondary canals and accessory works, such as the tram railroad, consols support for the water pipes and wiers, amounts to the sum of . .	$ 103,550·00*
The reservoir and flushing pipes, with communicating galleries, will cost	20,900·00
Total, .	$ 124,450·00

* Calling the 5 franc piece 94 cents.

I give now some mean prices resulting from the settlement of the accounts.

A running yard of the branch Bab-el-Oued, exclusive of man-holes, water-inlets, connexions, consols, &c., (mean price for the three sets of 3·93 ft., 4·26 ft., and 4·92 ft. of this branch,) .	$ 14·86
Do. for the branch of the Marine (two sections, 2·3 ft. and 3·3 ft. wide), ...	10·10
Do. for the branch Bab-Azoun, partly in open cut, (two sections, 3·93 ft. and 4·9 ft. wide,)	14·35
Do. for the branch Bab-Azoun, subterranean part, (four sets, 5·9 ft., 6·2 ft., 6·56 ft., and 13·12 ft. wide,) . .	41·43
Mean price per running yard of secondary canals (their widths varying between 1·3 ft. and 4·26 ft., with flag coverings or brick arches), .	4·03
Total expense of connexions relative to 110 private sewers, 69 gutters, and 24 urinals, ...	2,255·34
Mean price of one of these works, . . .	11·10
Do. of a simple man-hole, ...	73·32
Do. of a shaft with sumph attached, (exclusive of excavation,) .	282·18
Do. of a water-inlet with spare cast iron cover, . .	64·60
A running yard of tram railway, including the wagons, . .	9·40

All these prices should be increased 18 per cent. to allow for contingencies.

In terminating this article, I find I have gone farther than I intended at the commencement. It may, perhaps, be thought that I have allowed myself to be drawn into useless and uninteresting details. I accept the reproach at the outset. I make no pretensions here to anything new, either in the question of sanitary matters, or in the special art of constructing subterranean canals. My main purpose was simply to publish this extremely useful work which insured the health of a city and harbor, and which, in this regard, places the port of Algiers in an unquestioned superiority over that of many other ports, and especially that of Marseilles.

NOTES ON THE PRECEDING MEMOIR.

NOTE A.—*Upon the increase in the delivery of the branch Bab-Azoun, resulting from the modification adopted in the execution of this work.*

(See the profile of the branch Bab-Azoun, Pl. II, Fig. 3.)

It will be seen upon the longitudinal profile between Scipio street and the sea, that the line of springing has followed exactly the uniform slope of the adjudged plan, which is not quite ·01 ft. per foot. The invert lowered successively 1·47 ft., 2·13 ft., and 2·78 ft., lies parallel to the springing line, except at the lower part of 479 ft., where the slope is reduced to ·005 ft. per foot.

Each section carries a different volume of water. We will admit that this volume is the same throughout the length of the section. This is not exact in practice, since the section receives affluents throughout its course. But, if we consider that the greater portion of the additional liquid of each section of 5·9 ft., 6·23 ft., and 6·56 ft., enters precisely at the origin of the three united sewers of the rampart Bab-Azoun, Poudriere, and of Tivoli, we may regard the assumption as admissible for calculations.

As the question is to ascertain the maximum volume each stream will deliver, without exceeding the level of the springing line, and as their respective lengths are sufficiently great to produce a uniform motion between the falls, it is unnecessary to take the falls into account in the calculations. Their effect cannot be construed but by a diminution in the height of the water above and below, that is to say, between the limits of uniform motion in the two consecutive sections. The force of impulse of the falls will yet be in part counteracted by the shock of the water of the three ravine sewers.

We will suppose that the slope of the sections is exactly ·01 ft. per foot. This granted we will calculate the velocity by the reduced formula $v = 51\sqrt{\frac{p\,s}{c}}$ in units of metres, $v = 53{\cdot}33\sqrt{\frac{p\,s}{c}}$ in units of yds. p is the slope, s the section, and c the wetted perimeter. This formula becomes for the case where the slope is ·01 ft., $v = 5{\cdot}333\sqrt{\frac{s}{c}}$ in yards.

It gives, for the section of	1·64 yds.,	$v = 3{\cdot}66$ yds.
" "	1·97	$v = 4{\cdot}16$
" "	2·08	$v = 4{\cdot}34$
" "	2·19	$v = 4{\cdot}49$

It gives for the volumes delivered without surpassing the limits of the springing line,

	yds.	cub. yds. per sec.
For the section of	1 64	6·55
"	1·97	12·97
"	2·08	16·22
"	2·19	19·89

We must now compare these deliveries with the products of a storm of 0·16 ft. for the basins answering to each section.*

These basins are as follow:

Section of	1·64 yds.,	56·8 acres.
"	1 97	108·0
"	2·08	197·0
"	2·19	279·0

The section of 13·12 ft. does not deliver above that of 6 56 ft., other than the product of the Fort Bab-Azoun sewer. We must, then, consider the whole product of the Bab-Azoun basin as passing through the section of 6·56 ft.; it is for this reason that we have taken the 279 acres as belonging to this section.

The products of a storm of 0·16 ft. answering to the above areas, are as follow:

	yds.	cub. yds. per sec.
Basin of the section	1·64	4·17
"	1·97	7·99
"	2 08	14·53
"	2·19	20·53

These results show that the whole of the rain fall can be passed through the deepened sections of the Bab-Azoun branch without getting above the springing line.

The section of 6·56 ft. is that in which the water will reach its maximum depth; but we would observe that the conduit pipes only begin at the shaft T 14, and that the last 406 ft. of the section is wholly without these pipes.

It remains now to ascertain whether the whole volume of 20·53 cub. yds. per second, can pass through the section of 13·12 ft., whose slope is but ·005 ft. per foot. Though this portion has only a length of 479 ft., and though it is found between the inclined plane at the outlet of the sewer into the sea, and the sudden change in the condition of flow arising from the doubling of the section, we may still admit that a uniform motion will be established for a certain length upon the middle of the section. Admitting this, we proceed by trial to find the height of the water in the part where the uniform motion is established.

Supposing this height to be 4·59 ft., and taking account of the railroad causeway, in calculating the value of $\frac{s}{c}$, we find for the discharge of the 13·12 ft. section, 19·73 cub. yds. per second. It is then demonstrated that the whole volume of the storm of 0·16 ft. per hour, after passing through the deepened sections, will also pass through the enlarged section of 13·12 ft., without sensibly surpassing the level of the springing line.

* The storm of 0·164 ft. per hour, adopted here as the basis of the calculations, may be considered as a maximum but rarely produced. For ten years, the rain gauge operations of M. Engineer-in-Chief Don, have given for the maximum a fall of 0·16 ft., in 1 hour 30 minutes, which corresponds with a height of 0·108 ft. per hour.

Applying now the calculations to the original plan for the last section of 6·56 ft., we find that the whole discharge was restricted to 9·43 cub. yds. per second, with the condition of not exceeding the level of the springing line between T 14, and the ravine sewer of Tivoli; a discharge answering to the yield of a storm of ·075 ft. per hour.

The change has thus more than doubled the discharge of the branch Bab-Azoun. The wiers designed to be sometimes used in the system of the original project, will probably never be called into action, in that of the plan since modified and executed.

NOTE B.—*Effect of the proposed flushings in the sewer.*

We first present the elements of the calculations.

1. Branch Bab-Azoun.

	Feet.
Ordinate of the overfall of the reservoir,	72·00
" of the invert,	59·00
" of the inlet or centre of pipe at the head,	59·53
Height of water in the reservoir,	13·12
	Cub. yds.
Volume of the reservoir,	1758·00
	Feet.
Ordinate of the invert at head of branch,	52·48
" of centre of flushing pipe at its discharge in sewer,	52·97
Length of conduit,	361·00
Head on conduit,	19·03

2. Branch Bab-el-Oued.

The elements are the same except the following:

	Feet.
Ordinate of invert at head of branch,	53·98
" of centre of flushing pipe at its discharge in sewer,	54 48
Length of conduit,	584·00
Head on conduit,	17·14

3. Branch of the Marine.

The elements are the same except the following:

	Feet.
Ordinate of invert at head of branch,	47·79
" of centre of flushing pipe at its discharge in sewer,	48 28
Length of conduit,	869·00
Head on conduit,	23·87

The initial velocity of the flushing, or that of its discharge in sewer, if the reservoir remains constantly full, by Prony's formula (Genieys, page 153), will be,

	Feet.
At the head of the branch Bab-Azoun,	11·15
" " Bab-el-Oued,	8·36
" " Marine,	7·87

The section of the flushing pipe being equal to 0·772 sq. ft., the flushing will deliver the following quantities per second in each of the three branches:

	Imp. galls.
In the branch Bab-Azoun,	53
" Bab-el-Oued,	39·6
" Marine,	37·4

To ascertain the time of flushing in each branch, we will suppose the quantity issuing from the reservoir equal to 1700 cub. yds. only, and admit that it receives no supplies during the flushing. It is well known that the time required to empty a prismatic basin is double what would be needed to discharge all its waters, were the head to remain the same as at the commencement of the discharge. On this basis, the time of flushing in each branch would be:

	hrs.	min.	sec.
In the branch Bab-Azoun,	3	0	28
" Bab-el-Oued,	4	0	44
" Marine,	4	14	51

It is apparent that these flushings will be useless in the winter, for the least storm

will introduce into the main sewer quantities far above those just calculated, especially in the branch Bab-Azoun. But the flushing will have a great effect in hot weather and times of low water.

We may have an idea of this by comparing the delivery of the three branches with the quantity introduced by the flushing. I have not as yet gauged the quantity passed in sewer during the low stage, but it may be approximately calculated as follows:

The volume entering the city in summer is about 3924 cub. yds. for twenty-four hours, or, say, 7·7 Imp. galls. per second. We may admit that the loss from consumption, evaporation, &c., is compensated by the quantity derived from wells and cisterns, and adopt 7·7 galls. as representing the combined delivery of all the sewers of Algiers, in the low stage.

To make a just distribution of these 7·7 galls. among the three sewers, we must take as a basis not the general basins of each branch, but only the inhabited portion of each basin, for the uninhabited portions do not feed the sewers, since there are no rains, and because the ravines are dry at that time. Taking the inhabited parts of the basins, we have the following approximate surfaces:

	Acres.
Branch Bab-Azoun, ...	88·9
" Bab-el-Oued, ...	44·4
" Marine, ...	14·8
Sewer emptying directly outside of port, .	14·8
	162·9

Dividing the 7·7 galls. proportionately to these surfaces, we have for the delivery of each branch in the low stage, the following quantities per second:

	Cub. yds.
Branch Bab-Azoun, ...	272
" Bab-el-Oued, ...	179
" Marine, ...	64

During the flushing, these volumes will be each increased by 1700 cub. yds.; that is to say, that during this time, the volume of the branch Bab-Azoun will be multiplied by 7·25; that of the branch Bab-el-Oued, by 10 50; and that of the branch Marine, by 27·50. These results prove the advantage of flushing in hot weather.

It will be well to reduce the period of flushing in the branches Bab-el-Oued and Marine, or what is equivalent, to flush more frequently in the branch Bab-Azoun.

For the Journal of the Franklin Institute.

Upon Balancing Horizontal Direct-acting Screw Engines.

By Alban C. Stimers.

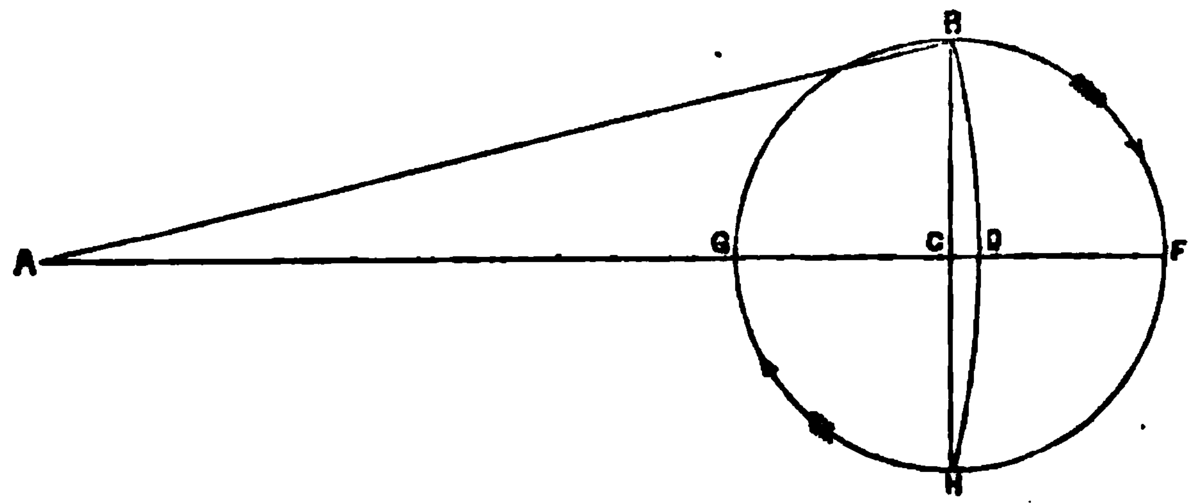
Great attention has been paid by engineers during the past few years to the subject of properly balancing *horizontal direct-acting screw engines.* The parts considered necessary to be balanced in this description of engine, are those which tend by their gravity to depress the crank-pin when the piston is at either end of its stroke, and, ordinarily, this is equal to the weight of the crank-pin, half the weight of the connecting-rod, and half the weight of the two cranks.

The practice of engineers has not materially differed about the *amount* of counter-balance which is required in each case, it being usual to apply sufficient weight upon the side of the shaft directly opposite the cranks to prevent the engine, when in a state of rest, having any tendency to move in either direction when the piston is at the end of the stroke. The improvements which have been made, have been in placing this counter-balance in the most favorable position.

The object of this paper is to show that an engine perfectly balanced

when in a state of rest is not balanced when in motion, and that if it is run in one direction the weight of the usual counter-balance is too great, while if it is run in the other, it is not sufficient.

Let A B, in the following diagram, represent the connecting-rod of a steam engine, of which B C is the crank and B F G the circle in which the crank-pin moves. The diameter of this circle, or G F, represents the stroke of the piston.



Now, if from the centre, A, and the radius, A B, equal to the length of the connecting-rod, the arc B D H is described; the point D will represent the position of the piston in the stroke G F, when the crank is in the vertical position, C B. This, it will be observed, is at a sensible distance from the middle of the stroke C, and if the engine is put in motion in the direction of the arrows, the half revolution, B F H, is made by a movement of the piston equal to 2 D F, and the other half revolution H G B by a movement of the piston equal to 2 D G, and as the times and piston pressures are equal during each of these half revolutions, the piston power available to drive the crank-pin from its highest to its lowest position, is less than that available to drive it from the lowest to the highest by 4 C D multiplied into the pressure transmitted from the piston to the crank-pin; and to remove this irregularity in the powers of the two half revolutions, it is necessary to have a preponderance at the crank-pin, which may be determined in any given case by the following formula:

$$w = \frac{p \times 2\,CD}{s}$$

where w = the preponderance required at the crank-pin, p = the total effective piston pressure, and s = the stroke of piston. Because $p \times 2\,CD$ is the amount of power which must be deducted from one-half revolution and added to the other, and if this power is obtained by adding unbalanced weight to the crank-pin, it is manifest that this weight moves through a perpendicular distance equal to the stroke of the piston, and the foot-pounds to be overcome, divided by the feet through which the weight acts, gives the number of pounds necessary.

To show that this quantity is not an insignificant one, we will take the case of the U. S. Frigate *Merrimack*, of which I happen to have the necessary data.

It may, with propriety, be premised that the connecting-rods, &c., of the engines of this vessel were above the average in weight compared to diameter of cylinder and length of stroke; that the piston pressure

was less than usual; and that the ratio of length of connecting-rod to length of stroke was fully equal to the average.

There were two horizontal back-action engines connected direct to the screw shaft.

Diameter of cylinder, ...	72 inches.
Stroke of piston, ...	3 feet.
Length of connecting-rod, . . .	7½ "
Mean effective pressure per square inch on the piston, being the average of more than 200 indicator diagrams taken during the year 1859, . . .	10·23 lbs.

From the above length of connecting-rod and stroke of piston, the distance C D is easily found by first obtaining the base A C of the right angled triangle A C B, which is ($\sqrt{7 \cdot 5^2 - 1 \cdot 5^2} =$) 7·34847, and then deducting this from the length of the connecting-rod, or A C, and we have ($7 \cdot 5 - 7 \cdot 34847 =$) 0·15153 as the value in feet of C D in the engines of the *Merrimack*.

From the mean effective pressure on the piston as given above, should be deducted that which is required to overcome the friction of the piston, piston rods, crosshead guides, and connecting-rod bearings; and as the air pump pistons are connected directly with the steam pistons by a rod passing through two stuffing boxes, there is the friction of the pump piston and piston rod, and the direct pressure upon the pump piston. This last was often obtained by means of indicator diagrams from the pumps themselves, and the usual average was 8 per cent. of the total effective pressure on the steam piston. It amounted, therefore, to ($10 \cdot 23 \times \cdot 08 =$) 0·8184 lbs. per square inch of the steam piston, which, deducted from the total, leaves ($10 \cdot 23 - 0 \cdot 8184 =$) 9·41 lbs., and if we assume that 1·41 lbs. per square inch of the steam piston pressure will overcome the loaded friction of the parts above enumerated, we shall probably not err much. This leaves 8 lbs. per square inch transmitted to the crank-pin, and to obtain the value of p in the foregoing formula the area of the piston must be multiplied by this amount. The area of a piston 72 inches diameter is 4071·5 square inches, therefore $p = 4071 \cdot 5 \times 8 = 32572$ lbs., and as $s = 3$, we have

$$w = \frac{32572 \times 2 \times 0 \cdot 15153}{3} = 3290 \text{ lbs.}$$

This is the preponderance which it is necessary there should exist at the crank-pin of the *Merrimack's* engines, to maintain them in a perfectly balanced state when running in the direction marked by the arrows of the foregoing diagram.

To determine now how much counterbalance there should be for running them in the direction shown, it is necessary to ascertain how much preponderance there is at the crank-pin without any balance.

The following are the weights which tend to depress the crank-pin when the piston is at the end of the stroke.

Half of one connecting-rod, complete, . .	1950 lbs.
Half of two cranks, ...	1315 "
One crank-pin, ...	485 "
Total,	3750 "

The counterbalance required, then, upon the side of the shaft directly opposite the cranks, and at the same distance from its centre as the crank-pin, is (3750 − 3290 =) 460 lbs.

By a similar process of reasoning, it may be shown that if the engine is run in a direction contrary to that marked by the arrows, the preponderance, instead of being required at the crank-pin, must be placed on the opposite side, and that in the case of the engines of the *Merrimack*, the counterbalance would require to be (3750 + 3290 =) 7040 lbs.

It so happens that the position of the two engines of this vessel is such that while the forward one runs in the direction shown by the arrows of the diagram, when the vessel is being driven ahead, the after one runs in the contrary direction.

The counterbalance for both engines is in one piece, and is placed, not only abaft the engines, but upon the after part of the loose coupling connecting the line of shafting, running out through the stern to the screw, with the crank shaft.

On account of its great distance from the forward engine it probably had very little influence upon it, and it is worthy of remark in this connection that this engine always worked much more smoothly and regularly than the after one.

It is quite the common practice now to run the engines of our screw steamers in the direction contrary to that shown by the arrows in the diagram, because the oblique action of the connecting-rod upon the crosshead guides is upward when running in this direction, whereas, when running the other way, this action is downward, the friction in the latter case being the oblique force of the rod *plus* the weight at the crosshead, and in the other direction the friction is only the *difference* between these quantities.

The engines of the *Merrimack* afford an excellent opportunity to judge of the importance of this subject, the oblique force of the connecting-rod pressing down upon the forward crosshead at the same time that it lifts the after one, and if the fears of constructing engineers were well founded, the former would heat and give trouble, while the latter would work to a charm. The reverse of this, however, was the case in fact. It was the forward crosshead that never gave trouble, while the after one required frequent attention, as it was important that there should be as little play in the guides as possible, because when a few inches of the stroke had been performed, the lifting force of the connecting-rod became sufficient to raise the crosshead against the upper guide, and when it arrived at a corresponding distance from the other end of the stroke, it would drop again to the lower slide, and it may easily be imagined that when heavy engines like those under consideration were making forty or fifty revolutions per minute, this lifting and dropping process was not a very gentle affair. The only way in which the blow could be softened was to make the distance through which the crosshead rose and fell as small as possible, and sometimes this would be reduced a trifle too much, and heating ensue as a natural consequence. Whereas the forward crosshead

always worked perfectly smooth and never gave the slightest trouble from heating or any other cause.

It appears preferable, therefore, to run the engines in the direction of the arrows for reasons entirely independent of any consideration of the counter-balance, and when to this is added the great convenience of having the engine balanced without the application of any counterbalance whatever, there should certainly be very little hesitation about it.

That to apply no counter-balance would be the proper course to pursue, is evident from an examination of the case of the *Merrimack*, which we have taken as an example, for it would only have required an increase of steam pressure upon the piston of 1¼ lbs. to have caused the engines to run in a perfectly balanced state, supposing them to be run in the direction of the arrows, and if the pressure was still more increased, there would require to be weight added to the crank-pin to maintain the balance perfect, but even in engines carrying much higher steam than those of the *Merrimack*, engineers would very properly hesitate to do this on account of the great irregularity with which the engines would run when reversed.

Steam Engineering in 1859.* *Recapitulation.* *Concluding Remarks.*

The first paper of this series appeared in the May number, and was intended to point out the avoidable difference existing between the present practice of steam engineering, and that which, if generally adopted, would result in many and undoubtable advantages.

It was intended also to indicate that steam engineers were practically neglecting to appreciate the only true principles in steam engineering, on which all economy must rest, and that with few exceptions, we are literally wasting money and time by allowing the manufacture of steam engines to degenerate into a mere trade.

During the past six months, several instances have occurred, in which the possibility of an indicated horse power being obtained from the consumption of 2½ lbs. of coal, has been more than verified, and these instances have, in many particulars, confirmed fully the truth of all we have stated in reference to the economy of steam power.

Paddle engines of considerable power are now regularly working with a consumption less than 2½ lbs. of coal per hour, and this is accomplished with all the disadvantages arising from the use of salt water. This creditable result is due, solely, to an intelligent appreciation, by the designer, of those truthful principles we have endeavored to recommend.

In another case of recent improvements in steam power, by an improved class of boiler, the use of distilled water, conservation of heat, and extensive development of the expansive principle, an indicated horse power has been realized by a consumption considerably less than 2 lbs. of coal per indicated horse power per hour.

*From the Lond. Artisan, Dec., 1859.

In another case, with more limited expansion and pure water for evaporation, the coal consumption has averaged for a considerable period less than 2½ lbs. per indicated horse power per hour.

The above cases in actual practice, are well authenticated, but it is unnecessary to remind the practical reader, that, in the application of steam power, many conditions have to be fulfilled besides that of economizing fuel; cost of construction, simplicity, safety, weight, space, durability, have all to be separately considered; and the greater the change introduced, the longer the time required to test it before it deserves the confidence of the public.

To insure the acceptance of our statements, even by those most indisposed to wander from the beaten track, in all cases we have stated *less* than the truth; that is, present defects have been leniently represented, and the advantage that may be obtained from attention to true principles of economy, has been underrated.

It must not be forgotten that the success of improvements, and more especially their general adoption, are greatly dependent on the moderation of the engineer who introduces them; many a fair and useful change has been kept in abeyance for years, by a want of moderation and judgment in the inventor. Experience teaches us that it requires more judgment to decide how and when to introduce an improvement, than it does to decide on the merits of the improvement itself.

In marine engineering, safety and the greatest possible freedom from risk must be secured, even, if necessary, at the cost of economy; and whoever introduces changes of a radical kind, incurs a heavy responsibility, and may, by a want of prudence, be a curse to his patrons and the profession; but this somewhat severe caution need not disturb or check the honest and earnest inventor; his success is certain, if he is moderate and *progressive.*

There are many good practical engineers and mechanics, but few practical philosophers—we polish the shell but waste the kernel. When shall we estimate the efficiency of a steam engine by the difference existing between heat expended and heat utilized? When shall we appreciate the vitality and importance of the true principles of economy, as distinct from mechanical construction? When shall we cease to sacrifice solid advantages to apathy, ignorance, and trade puffery?

In the June number, the generation of steam was considered, and we trust our readers will excuse our requesting particular attention to the statements made on that subject.

Statistics embracing a large field of observation have lately been published, giving accurate information on the duty and economy of the Lancashire engines and boilers, and we have the satisfaction of knowing that these statistics have most fully confirmed our own estimates, a matter of no slight importance, when it is remembered that present duty must form the basis from which all improvements spring.

A steam *engine* is attractive to the young steam engineer, but what does he care about the dirty black looking *boiler?* As a general rule (comparatively) he never takes any interest in boiler construction until he is thrown on his own resources, when he is compelled to do so to

maintain his credit and position; there are now hundreds of engineeers holding important and responsible positions, in positive ignorance of the laws that determine the economical efficiency of a steam boiler—dogmatism takes the place of knowledge, and we pick the fruit of such a state of things in wholesale waste.

Perfect combustion is the starting point in steam generation, and thanks to the perseverance of some, earnest in their adherence to first principles, there is a prospect of great improvement in the furnace arrangements of steam boilers; but it is extraordinary what time it takes to convince engineers that it is impossible to obtain a sufficient supply of air through the grate bars; or that perfect combustion is not attainable except at a very high temperature; and that space should be given to allow the air and gases to combine.

The conversion of coal and air into an equivalent of heat must be the first process—and then, as the second process, that heat can be applied with full effect—but the custom is, by low furnaces and contracted combustion chambers, to begin the second process before the first is half completed, the result being a certain loss.

With brick furnaces a much less space for combination and combustion is sufficient, as the furnace case approaches in temperature that of the furnace itself; but with furnaces inside a steam boiler it is quite different—the plates surrounding the fuel are always at a low temperature compared with that of combustion, and will, if in too close contact with the fuel, absolutely prevent the necessary temperature for perfect combustion ever being attained.

This is so self-evident that the present faulty construction of boiler furnace is quite unaccountable.

In the boilers of the *Great Eastern*, it is quite evident that they were designed in improved accordance with the right principles of construction we have alluded to—the combustion space being in excess of the general practice.

In the June and July numbers, we pointed out the characteristics of the wasteful and economical generation of steam, and as they are more neglected than any other connected with boiler construction, we must yet add a few more statements in illustration.

It must be allowed as undisputed that with an average rate of combustion and a given class of boiler, a certain amount of heat absorbing surface must be given to take up the heat generated in the furnace, minus what is required for draft in the uptake—if this surface is not given, a certain amount of the heat is transferred from the water to the chimney.

Referring to the tables of ratios in the June number, we find experience fully confirms the fact stated above; and it will be found without a single exception, *other points of construction being similar*, the evaporative duty obtained from a pound of coal is always proportionate to the ratio between the heating surface and the rate of combustion, a large ratio increasing, and a small ratio decreasing that duty.

It is matter of sincere regret that we have to select as one of the most striking cases of a neglect of the above undeviating principle of economy, the boilers of the *Great Eastern*.

In February, 1855, the late Mr. Brunel reported to the proprietors of the great ship, that much attention had been paid to economy of fuel in the design of the boilers, and that, to prevent a chance of error, an experimental boiler had been made. After such a report it might have been expected that a maximum evaporation would be obtained from the coal.

At pages 137 and 138, are given two experiments of evaporative duty in boilers of similar construction to those in the *Great Eastern*, except as to the ratio of heating surface to rate of combustion, which was, in the first case, 0·83 to 1, and in the second, 1·9 to 1. The difference of evaporative duty in these boilers was nearly 40 per cent.

In the boilers of the *Great Eastern* there are only some 20 square feet of heat absorbing surface to one square foot of fire grate, and with 100 ft. height of chimney, and a high temperature in the uptake, there is every reason to believe, the furnace, when fully supplied, would consume *at least* 20 lbs. of coal per square foot of fire grate, or 430 tons per day, and with dampers fully open, it is difficult to believe that less than 24 or 25 lbs. of coal were burnt per square foot of fire grate. No practical man, who has well considered the subject, can accept the statement, that when working the boilers at their full steaming power, the consumption of coal was only 309 tons a day, or 14 lbs. per square foot of fire grate.

It is no matter of surprise that the water jacket became a second boiler, for it is quite certain, with the deficient heating surface a high wasteful temperature in the uptake is inevitable.

The remedy in the case of the *Great Eastern* is to take away at least one-third of the grate surface, and adopt some plan for preventing the loss arising from condensation in the cylinder—the result of such alteration would be a considerable decrease of the coal consumption and a considerable increase in the power of the engines and the speed of the ship.

In steam generation it is simply a matter of *choice* with the steam engineer as to what evaporative duty (within certain limits) he obtains from the fuel—shall it be 6, 7, 8, 9, 10, or 11 lbs. of water evaporated by a pound of coal? He can obtain either result without any radical change in the construction or form of boiler.

Before leaving the subject of steam generation, we must once more revert to the defective circulation of the water in marine and locomotive boilers. It is somewhat difficult to estimate the amount of loss incurred by deficient circulation, but there is no difficulty in proving that a considerable loss of evaporation is incurred, and also that another certain evil results—namely, premature destruction of the conducting metal.

In the August number, "the application of steam as a motive power" was considered, and the importance of maintaining the temperature of the steam in its passage to and through the engine, and of avoiding all premature condensation, was strongly represented.

The economy to be derived from the steam case or jacket round the cylinder is still disputed, but it is strange that the bulk of the objectors to the jacket have, in no case, made a fair comparison of economy

by dynamometer or indicator, with and without the jacket. Cornish engineers object on account of the piston packing being affected by the heat given out by the jacket. To remedy this, the jacket was removed, and "they never noticed any increased consumption of coal." Most scientific conclusion, truly!!

In addition to the cases already given of economy derived from the application of steam jackets, we may add two more. In each case the experiments were carefully made with and without the jacket. In the first case a saving of 27 per cent. was realized with the jacket, and the water condensed in it was less than 5 per cent. of the total quantity evaporated.

In the second case the saving was 22 per cent. with the jacket. The water condensed in it not being ascertained.

There are two points worth consideration in estimating the economy to be derived from steam jackets in condensing engines. The first is, that there is condensation only, and no re-evaporation in the jacket as in the cylinder. And secondly, that during half of each stroke the condensation in the jacket is practically uniform at all rates of expansion. It must also be borne in mind the re-evaporation that takes place during the exhaust stroke in the cylinder, not only robs heat from it, but requires increased duty from the condenser.

Superheated steam with an old boiler is often an evidence of original defective construction, but applied to a well designed new boiler it has advantages difficult to obtain in any other way. Any plan by which a greater amount of useful effect can be derived from the heat generated in the furnace, is a step in the right direction, and time and experience alone will prove what effect the highly heated steam has upon the working valve and cylinder surfaces.

There is a striking similarity in the amount of economy derived from the use of steam jackets and that of superheated steam.

Without expansion, 40 lbs. weight of steam will give an indicated horse power; with an expansion of three times, or cut off at one-fourth the stroke, 18 lbs. weight of steam will give an indicated horse power, making no allowance for leakage or condensation. Supposing steam jackets applied, and allowing one-fifth for condensation, leakage, &c., and assuming 10 lbs. of water to be evaporated by one pound of coal, and the steam to be expanded three times, *practically* an indicated horse power can be obtained by the consumption of $2\frac{1}{4}$ lbs. of coal, just one-half of the present average consumption, and this result can be realized without any great change in engine or boiler construction; and be it remembered when this improvement has been effected, we have only *began* to economize. As a commencement, an average of $2\frac{1}{2}$ lbs. of coal to the indicated horse power will be acceptable, and when that is accomplished, we shall find many pioneers doing the same duty with one pound.

As the indicator does not give us the power absorbed in friction, in and beyond the machine, it is impossible to use it in comparing the efficiency of two engines of a different class; for instance, a compound or Woolf engine having the same indicated power and consumption of

coal as a single cylinder engine, would necessarily be the least efficient of the two from the increased friction.

The indicated power of the "*Great Eastern's*" engines has been published as 7600 when working full power, and consuming 300 tons of coal per day; this gives 3¾ lbs. of coal per indicated horse power per hour; but for reasons we have given as to the evaporative duty of the boilers, and from the limited expansion employed, it is to be feared that at least 4¾ or 5 lbs. are required per indicated horse power per hour; a most unsatisfactory result.

In some experiments with engines and boilers similar in proportion to those in the "*Great Eastern,*" 4¾ lbs. of coal were consumed per indicated horse power per hour, working under favorable circumstances; and from the class of engines adopted for the screw, a less favorable result even than that referred to, must be expected from them.

It may be taken for granted that if there had been sufficient boiler power in the "*Great Eastern*" to indicate the anticipated 10,000 actual horse power, at least 500 tons of coal would have been consumed per day.

Notwithstanding the adoption, by an eminent firm, of trunk engines for screw propulsion, as simple and compact in a mechanical point of view, they are, by their very construction and the cooling surface exposed, inadmissible as economical engines; and when we practically recognise the truth, that economy of fuel is the great desideratum, this description of engine will be as neglected as it deserves to be. For naval purposes, horizontal engines with double piston rods are almost equally compact with the trunk, and can be worked with very much less waste of fuel.

Reformation always springs from the people; as in politics and religion, so in science, those high in professional position are too often only the remote followers, and not, nay never, the pioneers, or even the encouragers of improvements.

To which of our great engineering firms is steam engineering indebted for a due attention to economical principles of construction? Do they not in daily practice ignore the existence of power in heat?

Strange, but most true is it, that the highest price is often given for steam machinery, in the arrangement of which there has been the least attention paid to economical efficiency.

We are loth to believe that the value of a steam engine is to be regulated solely by the excellence of its mechanism and workmanship.

It is quite certain that our government, through its engineering officials, has been instrumental, to an alarming extent, in repressing improvement, and encouraging the "let alone" system in the steam machinery of the navy.

A few fortunate inventors, by (to them) an age of perseverance and a determination not to be discouraged by any amount of official ignorance and red tapeism, have succeeded in obtaining a fair trial of their inventions; but most men who have matured improvements, will not subject themselves to the uncertainty of governmental patronage.

For instance, if an engineer succeeds in reducing the present con-

sumption of fuel by some well proved improvements on boilers or engines, he dare not submit his plans to the Admiralty, because he knows too well the jury will have to give the verdict; and if the great contracting firms who supply Government with marine engines of the old wasteful type, should disapprove his new plans, where is there a court of appeal? He is forewarned by the experience of others, that the chances are one hundred to one against him.

Better days may, and they assuredly will, come, when all who are competent will be allowed to compete for Government orders, and at the present moment the list of privileged firms is being wisely extended.

It would be difficult to estimate the advantage to the country of offering a premium for the best arrangement of steam machinery for the gunboats; they are used in a service that requires them to have the following qualifications: *First*, to be easily concealed from the sight or hearing of the enemy; *Secondly*, to go the greatest distance with the least weight of fuel; *Thirdly*, to require a minimum amount of repair; and, *Fourthly*, to be able to raise steam at the shortest notice: these are the requirements of the service they are built for. How are they fulfilled?

1. They have a puff blast in the chimney to attract the sight and hearing of the enemy.

2. They are wasteful on fuel and go the least possible distance with a maximum consumption.

3. They require more decided, extensive, and constant repair than any other class of machinery in Her Majesty's Steam Navy, and

4. From two to three hours are required to raise the steam.

Never surely, was there a more striking instance of success in trying "how not to do it."

There is no difficulty whatever by simple and inexpensive alteration in the gunboat boilers and engines, in getting rid of the steam blast in the chimney; reducing the consumption of fuel one-half, to accomplish the same distance as before, or in other words to propel the boats twice the distance for the same amount of fuel; supplying the boilers with pure water, thus avoiding the heavy repairs rendered necessary by the use of salt water in small boilers that cannot be cleaned; and lastly, raising the steam in one-fourth the time required at present.

To those entering the field of steam engineering, we would say, despise no man's opinion or experience—hear all you can, but be careful what you retain for use—those engineers who have been noted for their disrespect and contempt for the opinions of others, are always those who have much the greatest blunders in their own practice.

Successful engineering consists greatly in a wise selection from an extensive experience, and not from that alone of one individual, which is necessarily partial and limited.

In the design and construction of steam engines, the manufacturer is seldom in a position to keep pace with the requirements of the users of steam power, and in proposing changes of construction, tending to economize, he has some difficulty in obtaining compensation for additional cost in increasing the duty realized from a given amount of fuel.

If in the construction of railways it was found necessary to introduce

a professional man between the proprietor and the contractor, it is still more necessary in the construction of steam machinery, if it is wished to have that machinery designed on the best principles.

At the same time, however, we fear steam engineers of the ability and judgment necessary to take this middle position, are very difficult to be found, and too often the duties are undertaken by incompetent and inexperienced men, who by their blunders create a prejudice against a division of labor that benefits both the user and the manufacturer of steam machinery.

The wide, and we may add, the opening field of steam engineering is full of promise, indeed there is no branch of engineering to be compared with it as regards a certainty of radical and extensive improvement.

In marine engineering, alone, a lifetime is required to make but limited progress, and the influence of that progress will be felt throughout the whole world.

Finally, we must express the hope that these papers will not be entirely fruitless, but that some of our readers will, by their perusal, be induced to assist in the great and important work of STEAM REFORMATION.

MECHANICS, PHYSICS, AND CHEMISTRY.

*What should Mechanical Workmen be Taught?**

On Saturday afternoon, the 4th of June, a lecture on this subject was delivered, at the South Kensington Museum, by Mr. J. Scott Russell, F.R.S. The following abstract of it is principally taken from the report in the *Builder:*

The lecturer commenced by observing that he had the honor of appearing before them in a somewhat unusual capacity, in consequence of a conversation which had taken place not long ago between one of that great establishment and himself on the subject of the education of the class of workmen to whom he (Mr. Russell) belonged. Mr. Cole had shown him some papers which he had prepared for the purpose of examining workmen as to the progress which they had made in the kind of education generally provided for them; and expressed to him what he (Mr. Russell) now expressed, that the education provided in this country for workmen was not that which was very directly calculated to render them good workmen. He did not mean to infer that education did not make us all the better and wiser,—at all events it put into our hands the means of acquiring knowledge, and therefore reading, writing, drawing, and accounting, were good for the skilled workmen, and for every body else. It did not, however, consort with his experience that the best reader and the best writer were always the most skilled workmen; on the contrary, the best man he ever knew could neither read, write, nor account, and yet he was a very admirable workman. As a large employer of skilled labor, he now asked whether there was any description of education which, in their

* From the Journal of the Society of Arts, No. 344.

opinion, would tend greatly to the increase of the skill, dexterity, ability, and success, of the practical working mechanic. He maintained that there was, but that the mechanic did not get it. It was extremely difficult to give, but if the rising teachers of the next generation—if the institution in which they were then met—if the Government—really and earnestly cared about the mechanic, and wished to make him a good and skilled workman, and wished to keep the next generation of workmen where English workmen had ever been—namely, at the head of the workmen of Europe—he would show what it was their duty to do, and what ought to be done. It was, no doubt, difficult to accomplish; but, if they all pulled together, it could be done. It would want a good deal of money, large and wise views, and great energy and self-denial. Having said thus much of the difficulties of the undertaking, he would recommend them not to be disheartened, as, if a little seed were sown, a little agitation commenced, and a little ventilation given to the matter, the Government might be induced to do all that ought to be done. The matter, moreover, was a serious one, because the Governments of other countries were doing a great deal for the education of their practical mechanics, which we, as a nation, were not doing. He himself was obliged to get his very best draftsmen and mechanics from foreign countries. He had men in his employment from Prussia, Germany, and Holland; and he was bound to say, that, as far as preliminary education was concerned, although the workmen of foreign countries had not the skill obtained by the British workmen from practical experience, their scientific knowledge was greater, and that knowledge was telling so rapidly on the present generation of workmen, that we were now equalled (he would not say excelled) by the workmen of many countries upon whom we were inclined to look down a few years ago. He hoped they would clearly understand that he did not say anything against the education now given. On the contrary, he would say, "Continue to teach drawing, reading, writing, and accounting, in the best manner you can; but if you have a class of young workmen coming forward to learn, think how you can turn the little time they can afford to give to the best advantage, so that you may raise them higher in the social scale and make them better workmen." In order to do this, it would be necessary to give them a higher class of education than they were ever taught before. They had already been taught arithmetic, and they could answer such questions as, "How many yards of ribbon at 3½d. can be bought for 30s.?" Now this was all very right and proper for shopmen and shopwomen, but would not do for mechanics. They were also taught geometry. They were taught the 16th, 17th, 18th, and 19th propositions of Euclid, but that description of knowledge was not of the slightest use to his workmen, or to any body else. They were also taught mechanics and the law of the lever. That was right; but then mechanics and the law of the lever were not ordinarily taught in books in such a way as to be of practical use to the British workman. We did not go far enough; but the pupil teachers whom he addressed were not to blame. The persons to blame were their teachers.

Two years was, perhaps, all the time that could be devoted to education, and six months were often devoted to as many books of Euclid, which were wasted for all practical purposes, unless, indeed, the student intended to become a professor. He would advise them to skip over the beginning, and devote the least possible time to Euclid—in fact, he would advise them to do a very heterodox thing—to cut off all the propositions but the useful ones. They might naturally exclaim: "Then how little will be left." Very little, he admitted—but plane trigonometry would be left. Suppose, for instance, a man had but six months in which to learn. Six weeks might, in that case, be given to Euclid, and then trigonometry might be commenced, solid geometry might next follow, and that constituted the whole education of the workman. But that was precisely what he did not get in the present day. He would also teach, in the six months, conic sections, and afterwards the nature of curves, within the first, second, third, and fourth degrees. He was aware he might be met by the exclamation—"Oh! but we shall be teaching them more than we ourselves understand:" but to this he would answer—"That is the fault of your education." Sir Isaac Newton discovered no less than 130 curves, and nine-tenths of them would be of great use to the mechanic, if he had them in two places—in his head and at his fingers ends. Having now got to teaching something which they did not know, and had not learned, the next thing they wanted was the assistance of the Government. Decent elementary text books were wanted for the higher departments in mechanics, but there were many able men versed in the sciences; and what he wanted the Department of Science and Art and the Government to do, was, to ask the four cleverest men in England to write, in the fewest possible English words, all that they knew, (not all that they had read,) or in fact so much of their brains as they carried about with them. If Government would but pay handsomely for these books, a set of treatises might be collected, such as the world never saw before, and such as would be sufficient to teach any mechanic his business. They might, it was true, say, "But we do not know where to get these clever men." But he knew where they were to be got. There were three of the four present at that moment; and if the Government would but give them a thousand pounds a-piece for writing the books, he was sure they would write them. What he said about geometry was true as to mathematics. Thirteen yards and a half at 3½d. was not what was wanted. Of far more importance to the working man was the comprehension of the laws and relations of numbers, so as to enable the working man to think in figures about the immediate business before him. Having explained the manner in which mechanics might make reduced or enlarged models, and the relations and practical properties of numbers, the lecturer illustrated the value of a knowledge on these points by an anecdote. He remembered an instance in which a respectable working man sent in a tender for £12,500 for a very large piece of work. The tender appeared to be low, and he obtained the order, and had got on some way with the work when he found he had made a trifling omission—he had forgot

to multiply by *two*. His figures were all right, but in one place he forgot his multiplication, and his whole calculations were wrong. He was of the opinion that geometry ought to be taught by a large and comprehensive system. Professor Airy had written the best and the clearest treatise the world ever saw upon weight or gravitation. It was published in the *Penny Cyclopædia*, and he recommended every working man to read it; for although the subject might appear to be a dry one, he would assure them it was most fascinating. Eilaw's Mathematical Treatise was also a succinct and admirable work, which would be found of the utmost practical utility to the working mechanic. The first and most important doctrine to remember in mathematics, was, that shape is not size and size is not shape. This might appear to be an axiom, and he thought it was as good as any in Euclid. The doctrine of similar triangles was a fundamental principle entitled to the dignity of an axiom: it was that, without regard to shape and size, any number of triangles might be made all of the same shape and not of the same size. Mr. Russell having illustrated this principle by drawings on the board, continued to say that, with respect to solid geometry, the two great duties in a workman's life were conversion of materials and adaptation to strength. A mason who used up a wrong stone, or a carpenter who selected a wrong plank, or piece of timber, showed that he was ignorant of one of the most useful portions of his art or calling. Now nothing would teach conversion of materials like solid geometry; it was, in fact, the daily business of the workman. It had been said that every block of marble cut from the quarry contained a beautiful statue, but the art was how to get it out of it. This was very true; for what workmen wanted to know was every shape, and how to get out another shape. The workman who took from a heap a block of stone or piece of timber that cost his master 50s., when a piece could be got answering quite as well which cost 25s., inflicted a loss upon his employer perhaps equal to a week's wages. Hence the necessity of acquiring a knowledge of solid geometry. But if there were beauty in the quantity of numbers, and in regular geometrical figures, there was infinitely more beauty in curves. It was the duty of many mechanics, especially of those engaged in ship building, to make curved lines. To him it had always been an interesting subject to learn how curves grew. He was aware that he might be told that the higher curves were never taught, but his answer was, that they might easily be taught, and that they were very easy of comprehension. In order to effect this, somebody who understood the subject, would have to be prevailed upon, not to write a book, but to put down in the shortest and plainest language what he knew of curves. This would be a treatise which the workman could understand, and would be well worth the thousand pounds which he hoped the Government would be prevailed upon to give to one of the four clever men to write. The lecturer then explained, with the aid of the board, the various mathematical figures known as conic sections, parabola, ellipse, hyperbola, and the movement of the comets. These, he contended, might be learned so as to make the workman master of the

principle within six months. The subject of the education of the workman was one which he had very much at heart. He did not know how it was to be given, but as the pupil teachers were present as an Institution which took charge of the mechanic, and a Government which was anxious for the spread of education, he would urgently beg of them to take counsel with half-a-dozen of the best mathematicians of the day, and arrange with them to write short treatises, which could be circulated at a cheap rate, and which could be taught in our elementary schools. He also thought that there ought to be a large quantity of apparatus—a sort of inventory of education—of every conceivable shape and object. In addition to these models, he would have the school-room hung round, not with pictures of animals, but with solid bodies, which could be explained and drawn. He would, in fact, impart any kind of practical rather than book knowledge. If drawings merely were used instead of models, he did not think the student could imbibe so correct a notion of the object to be produced or delineated. There was a mode of studying forms called *la théorie de développement*, but the plain English meant nothing more than making flat surfaces into round and angular forms (as models now made from sheets of paper, which was a most valuable mode of studying forms). If this description of education could be given, he would take the pupils educated in that department and give them three guineas a week. He might afterwards raise them to foremen with salaries of £500 a year, and that would be far better than remaining all their lives at the bench, earning 30s. a week. Machinery could now be obtained to do all the unintellectual drudgery of mechanism. He was not opposed to machinery and had no apprehension that it would supersede skilled intellectual handicraft. He would employ machinery to do all the drudgery that degraded the workman into a beast of burden. He would give him higher views of mathematics; he would show him that he was an intellectual, thinking being, with a soul for high and immortal things.

Mr. Russell concluded by expressing a hope that Government would seriously undertake the education of the working man, so as to enable us to maintain our superiority among the civilized nations of the world.

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*On the Tensile and Compressive Strength of various kinds of Glass.**

At a recent meeting of the Royal Society a communication was read "On the Resistance of Glass Globes and Cylinders to collapse from external pressure, and on the Tensile and Compressive Strength of various kinds of Glass," by William Fairbairn and T. Tate.

The researches contained in this paper are in continuance of those upon the Resistance of Wrought Iron Tubes to collapse, which have been published in the "Philosophical Transactions" for 1858. The results arrived at in these experiments were so important as to suggest further inquiry under the same conditions of rupture with other materials; and glass was selected, not only as differing widely in its physical properties from wrought iron, and hence, well fitted to extend our

* From the Lond. Builder, No. 859.

knowledge of the laws of collapse, but because our acquaintance with its strength in the various forms in which it is employed in the arts and in scientific research is very limited. To arrive at satisfactory conclusions, the experiments on this material were extended so as to embrace the direct tenacity, the resistance to compression, and the resistance to bursting, as well as the resistance to collapse.

The glass experimented upon was of three kinds:—

	Specific gravity.
Best Flint Glass, . . .	3·0782
Common Green Glass, . . .	2·5284
Extra White Crown Glass, . .	2·4504

Tenacity of Glass.—For reasons detailed by the authors, the experiments upon the direct tenacity of glass made by tearing specimens asunder are less satisfactory than those in the rest of the paper; and it is argued that more reliance is to be placed upon the tenacity deduced from the experiments on the resistance of globes to bursting in which water-pressure was employed, than upon the tenacity obtained directly by tearing specimens asunder. The results obtained by the latter method give the following mean results:—

	Tenacity per square inch in pounds.
Flint glass, . . .	2413
Green Glass, ...	2896
Crown Glass, . . .	2346

Resistance of Glass to Crushing.—The experiments in this section were made upon small cylinders and cubes of glass crushed between parallel steel surfaces by means of a lever. The cylinders were cut of the required length from rods drawn to the required diameter, when molten, and then annealed, in this way retaining the exterior and first cooled skin of glass. The cubes were cut from much larger portions, and were in consequence probably in a less perfect condition as regards annealing. Hence, as might have been anticipated, the results upon the two classes of specimens, although consistent in each case, differ widely from one another.

The mean compressive resistance of the cylinders, varying in height from 1 to 2 inches, and about ·75 inch in diameter, is given in the following table:—

Description of Glass.	Height of Cylinder in Inches.	Mean Crushing Weight per square inch.		Mean Crushing Weight per square inch.	
		In Pounds.	In Tons.	In Pounds.	In Tons.
Flint Glass, .	1·0 1·5 2·0	29,168 20,775 32,803	13·021 9·274 14·644	27,582	12·313
Green Glass, .	1·0 1·5 2·0	22,583 35,029 38,105	10·081 15·628 16·971	31,876	14·227
Crown Glass, .	1·0 1·5	23,181 38,825	10·348 17·332	31,003	13,840

The specimens were crushed almost to powder by the violence of the

concussion; it appeared, however, that the fracture occurred in vertical planes, splitting up the specimen in all directions. Cracks were noticed to form some time before the specimen finally gave way; then these rapidly increased in number, splitting the glass into innumerable prisms, which finally bent or broke, and the specimen was destroyed.

The following table gives the results of the experiments upon the cut cubes of glass:—

	Mean Resistance to Crushing.	
	In Pounds.	In Tons.
Flint Glass, . .	13,130	6·861
Green Glass, . .	20,206	9·010
Crown Glass, . .	21,867	9·762

Hence, comparing the results on cylinders with those on cubes, we find a mean superiority in the former case in the ratio of 1·6 : 1, due to the more perfect annealing of the glass.

Aerometry. Translated from the Hydraulics of D'Aubuisson de Voisins. By J. Bennett.

(Continued from page 241.)

THIRD SECTION.

We come now to the consideration of the force and the use of air as a motor; of its force, insomuch as it communicates motion by its impulse, or destroys it by its resistance; of its use, in that it gives motion to windmills (vessels coming under the special domain of the nautical art).

Chapter I.—*The Shock and Resistance of Air.*

All authors have regarded as identical the effects of the shock of air, and those of its resistance. If they differ at all, it can only be by a very small quantity, and in their constant co-efficient; for otherwise, they follow the same laws, and we proceed to discuss them under the common name of *resistance.*

545. *Mode of establishing the Resistances.*—The experiments and observations of Borda and of Hutton, have led to satisfactory results upon this matter; I give the substance of them, and refer for the developments and details to the works of these two authors.*

I first give an idea of the contrivance used by them.

Imagine a movable cylinder upon two small pivots traversed perpendicularly to its axis by a rod, whose two halves make equal arms. At their extremity is fixed the body whose resistance is to be proved; and around the cylinder is wound a cord having different weights suspended at its end.

In operating, the weight is allowed to descend, and impresses upon the machine a motion of rotation which soon becomes uniform. This

* *Experiences sur la resistance des fluides*, par Borda. *Memoires de l'Academie des Sciences*, 1763. *Determination of the resistance of air: 36th of the Mathematical tracts, and philosophical subjects, &c.*, by Hutton, 1812.

weight measures the resistance experienced by the body and the two arms: the latter found by a previous trial being deducted from the whole, gives that of the body. The velocity is known from the number of revolutions made by the machine in a given time.

546. *Laws of Resistance.*—The velocities of bodies moving in air are distinguished into small and great. The first do not exceed 33 ft.; the second, such as cannon balls and other projectiles, have been observed by Hutton from 328 ft. to 2000 ft.

At common velocities, the resistance is sensibly proportional to the square of the velocity. Thus, Borda, having fixed to his small mill square plates of ·1259 sq. ft., and having moved them with velocities from 6·7 ft. up to 29 ft., found that the resistances and the squares of velocities followed the same ratio, as may be seen below. Other experiments upon plates of ·279 sq. ft. and 6·34 sq. ft., have given the same equality.

Ratios	
of Resistances.	of Squares of Velocities.
1·00	1·000
0·50	0·499
0·25	0·247
0·125	0·124
0·062	0·062

At great velocities, the expression of the ratio between the resistance and the velocity is more complicated. Observation caused Hutton to express it by three terms: in one, the velocity is of the second power, in the second it is of the first power, and the third is constant. Designating by v the velocity of a ball, by d its diameter, the resistance is expressed by the following formula:—

$$d^2\,(\cdot 000068\,v^2 - \cdot 0161\,v + \cdot 674).$$

We observe that, the velocity of atmospheric air in a vacuum being 1296 ft. $= \sqrt{2\,g \times 26099}$, whenever the ball has a velocity over 1312 ft., there will be a perfect void behind it; and so the additional resistances will be constant and equal to the atmospheric pressure.

547. The resistance of air, as well as that of water (257), increases in a greater ratio than the surface of bodies impinging upon it.

Thus, the surfaces of the three plates of Borda, being as the numbers 1, 2·25, 5·06; the resistances were as 1, 2·44, 5·97; and thus have increased very nearly as the 1·1 power of their surface.

Hutton had similar results even upon similar bodies: thus, with two hemispheres presenting in motion their great circles, having areas as 1 to 1·8, he found the resistances as 1 to 2·06. In other experiments of the same author, the difference was a little less, but there always was a difference.

The effect of impulse of the air upon a surface would very probably be increased by surrounding it with a border (239). A similar effect is produced in giving a concave form to the surface shocked; sails, slightly bellying, impress a greater velocity upon vessels, though the

sagitta of the curvature should not be more than a fourth or third of the width of the sails.

548. All else being equal, the resistance of fluids is proportional to their density.

That of water being nearly constant, there was no call for its introduction in the formulæ of resistance of this fluid; its value was comprised in that of the constant co-efficient. But this is not the case with air, whose density varies from place to place with the season, and at different intervals, according to the state of the barometer and thermometer. It is proportional to the specific weight, which is

$$\cdot 03253 \frac{b}{1 + \cdot 0022\,(t - 32^\circ)} \ (498).$$

549. *Resistance for Plates.*—Let ρ be this weight, s the plane surface shocked, and n a numerical co-efficient; we shall have for the resistance, in velocities below 33 ft., $n\,\rho,\ s^{1\cdot 1}\,v^2$.

To determine n, I return to the experiments of Borda. He found that a plate with ·6388 sq. ft. of surface, moving with a velocity of 11·36 ft., met a resistance of ·1672 lbs.; the barometer was then at 2·4846 ft. and the thermometer at 41°, which gives $\rho = \cdot 07924$: we have, consequently, $\cdot 1672 = n \times \cdot 07924\,(\cdot 63886)^{1\cdot 1}(11\cdot 361)^2$, whence we deduce $n = \cdot 02677$; with the plate of ·2798 sq. ft., he had ·02636; with that of ·1259 sq. ft., ·02653.

A plate of ·2222 sq. ft. used by Hutton, gave ·02581. Thus, we may establish for the expression of the resistance perpendicular to a thin plate, $0\cdot 026\,\rho_1\,s^{1\cdot 1}v^2$.

550. *Oblique Shock.*—When a body is presented obliquely to the shock of air, it meets with less resistance. To determine the relation between the resistance and the obliquity, Hutton took a rectangular plate, ·665 ft. at the base, and ·334 ft. in height; it was fitted to his small mill so as to have different angles from 0° to 90° with the direction of the motion. Calling i the angle of inclination, he found that this ratio was given with sufficient correctness by $(\sin. i)^{1\cdot 84 \cos. i}$. So that the general expression of resistance for a thin plane body, would be

$$0\cdot 026\,\rho_1\,s^{1\cdot 1}\,v^2\,(\sin. i)^{1\cdot 84 \cos. i}.$$

Here v represents either the velocity of the body when it moves in still air, or the velocity of the air as it impinges upon the body at rest, or the relative velocity $(v \mp u)$, when the fluid and body are both in motion.

551. *Resistance for differently formed Solids.*—Though the above expression refers particularly to simple plates or to very thin bodies, it may yet serve for all solids presenting a plane surface to the action of the air; observing, however, that their resistance is less by some hundredths.

But, it does not apply to bodies presenting an angle or convex surface; their resistance is much less. Borda and Hutton devoted themselves to its determination for triangular prisms, having two equal lateral faces, for cones, for demi-cylinders, and hemispheres. Each of these surfaces was first moved, presenting its plane surface to

the shock, and its resistance was adopted as the unit: then, the edge of the plane angle contained between the two equal faces for prisms, was placed in front, or the summit for the cones, or the convex surface for the demi-cylinder and the hemisphere. The resistance obtained, compared with that of the plane surface of the same body, is noted in the following table.

Alongside of the results of experiment, I indicate those of the ancient theory, or that which regarded the resistance as proportional to the square of the sine of the angle of incidence, and where, for a curved surface, the integral of the resistance of its differential element (267) was taken.

Each experiment presents by the initial letter of the name of Borda or Hutton, the indication of its author.

KIND OF BODIES.	RESULTS of Experiment on n'.	RESULTS of Ancient Theory.
B. Prism, at a plane angle of 90°, ...	0·728	0·50
B. Prism, 60°, . . .	0·520	0·25
B. Cone, angle at summit of 90°, ...	0·691	0·50
B. Cone, 60°, . . .	0·543	0·25
H. Cone, 51° 22′, . . .	0·433	0·19
B. Demi-cylinder, ...	0·570	0·67
B. Hemisphere and entire sphere, ...	0·410	0·50
H. Hemisphere, ...	0·413	0·50

The resistance of these will then be very nearly expressed by

$$0·026\, n' \rho_1\, s_1^{1·1} v^2,$$

n' being the co-efficient indicated in the table, and s_1 the projection of the surface shocked, upon a plane perpendicular to the direction of motion.

552. *Examples.*—To determine the effort to be exerted by a current of air upon a plate 10·76 sq. ft. of surface, against which it impinges perpendicularly, with a velocity of 26·24 ft., the condition of the atmosphere being that of the mean for France. We have, then, the height of the barometer, $b = 2·477$ ft., and that of the thermometer, $t = 53·6°$; consequently, $\rho_1 = ·07687$. Moreover, $s = 10·76$ and $s^{1·1} = 13·65$, $v = 26·247$ ft. and $v^2 = 688·9$. These values substituted in the expression $·026\, \rho_1\, s^{1·1} v^2$, give 18·79 lbs. for the required effort.

I give in the following table the effort exerted by different winds upon the same plate.

KIND OF WINDS.	VELOCITY per second.	VELOCITY per hour.	EFFORT upon 10·76 sq. ft.
	feet.	miles.	lbs.
Gentle wind, ...	6·56	4·3	1·19
Fresh breeze, ...	19·68	13·6	10·70
Wind best for mills, ...	22 96	15·5	14 60
Stiff breeze (good for navigation),	29 52	19 8	24·10
High wind, ...	39·36	26·7	42·9
Very high wind, ...	49·20	33·5	67
Gale, ...	65 60	44·7	119

Storms occur where the velocity is as high as 131 ft. to 147 ft., with force sufficient to upset houses.

II. A very high wind with 33 ft. velocity, impinges against a sail or rectangular plane

surface, 33 ft. base, and 6·5 ft. high, and inclined as a mean at 70° with the direction of the wind. What effort does it resist?

We have $s = 214·5$ sq. ft. and $s^{1·1} = 366·9$ sq. ft., $v = 33$ ft. and $v^2 = 1089$; as above we make $\rho_1 = ·07687$: thus the direct shock would be $·026 \times ·07687 \times 366·9 \times 1089 = 798·6$ lbs. We must multiply by $(\sin. i)^{1·84 \cos. i}$, or since $i = 70°$, by $0·9397^{1·84 \times 0·342} = 0·9397^{0·6292} = 0·9616$; and we have 767·9.

III. A ball 0 1968 ft. diameter, is impressed with a velocity of 21·32 ft. against a current of air having a velocity of 8·2 ft.; the barometer is at 2·46 ft. and the thermometer at 68°; what will be the resistance experienced by the ball?

The relative velocity of the shock is $8·2 + 21\,32 = 29·52$ ft.; the surface s, which is the area of the great circle, is $\pi^1 \times (·1968)^2 = ·030418$ sq. ft. Moreover,

$$\rho_1 = ·032533 \, \frac{2·46}{1 + ·00222(t - 32°)} = 0·0741 \text{ lbs.};$$ and the table of No. (551) gives $n' = 0·41$. Thus the required resistance will be $·026 \times 0·41 \times ·0741 \times ·030418 \times 29\,52^2 = 0·02094$ lbs., which will be the retarding force.

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CHAPTER II.—*Windmills.*

553. *Parts and Principal Dimensions.*—The part of these mills which receives the action of the wind, which is all that we shall consider here, consists, 1st, of a strong shaft of wood, from 1·64 to 1·97 ft. square, established at the upper part of the mill, which is turned and set with it, so as to be always in the face of the wind; it is generally inclined from 10° to 15° with the horizon. 2d, Of two other pieces, about 79 ft. long and 0·98 ft. square, fixed across the head of the shaft; these form the four arms. 3d, At 6·5 ft. from the centre of rotation, each is traversed perpendicularly to its length by the first cross-bar 6·5 ft. long, making an angle of 30° with the plane of the four arms, or the plane of motion; then, at intervals of 1·3 ft., are placed similar cross-bars, but inclined less and less, so that that which is at the end may have an angle from 12° to 6° according as the shaft is more or less inclined to the horizon. The ends of the cross-bars on both sides are stayed by two other struts. The whole combined, constitutes a wing of the mill. 4th, Upon this is stretched a cloth or sail to receive the action of the wind. Such are quite nearly the dimensions and disposition of the well-constructed Holland mills. Their sails, on account of the arrangement of the cross-bars and sometimes of a slight curvature of the arms, present a concavity to the wind, and we have seen that such a form increases the effect of the machine.

554. *Best Disposition of the Wings.*—Mathematicians have studied the best form and inclination to be given to the wings, or, as it is technically termed, the best method of weathering them.

Parent, who first investigated this matter, as well as nearly all the machines moved by fluids, in supposing the wings to be entirely plane, concluded that it was necessary to incline them 54° 44′ to the direction of the wind, or what amounts to the same, 35° 16′ upon the plane of motion. He admits that the effort of the wind is proportional to the square of the angle of incidence, to $\sin.^2 i$, calling i this angle; its component in the direction of motion, and so its motive effort being proportional to $\sin.^2 i \cos. i$, it must be the greatest possible when this expression is a *maximum*; now differentiating and making equal to zero, we have $\text{tang. } i = \sqrt{2}$, and, consequently, $i = 54° 44′$.

In the hypothesis admitted by Parent such is the angle of the greatest effort when the sail is at rest; but not so when it is in motion. Bernouilli has shown that the angle increases, or that its complement, the angle with the plane of motion, diminishes with the increased velocity of the sails. Maclaurin also remarks that the velocity of the different transverse elements of the same sail increasing with the distance from the axis of

rotation, their inclination should be diminished, and he gives the value of the angle of each for the greatest effect.

Euler, in his theory of windmills, first supposing the surface of the sails to be plane, finds that the effect is proportional to the surface, to the cube of velocity of the wind, and to the cube of the sine of the angle of incidence. Then, varying the inclination of the transverse elements, he has the same value as Maclaurin for the greatest effect; but he gives no finite expression of this effect.

M. Coriolis has the formula $\cot. j = \frac{3\,w\,x}{2\,v} + \sqrt{2 + \left(\frac{3\,w\,x}{2\,v}\right)^2}$, designating by v the velocity of the wind, by w the angular velocity of the sails, by x the distance of one of the transverse elements from the axis of rotation, and by j its inclination to the plane of motion. He used this expression in the research for the maximum effect of the sail. He gives its differential equation, and shows the manner of applying it. He has made some important remarks upon this subject, for which reference may be made to his work upon the "*Calcul de l'Effet des Machines*" (p. 210–230).

555. Experiment has aided in the elucidation and decision of this question. It has been handled intelligently and successfully by Smeaton.*

This engineer made use of a small mill with four sails, each of which was 1·5 ft. long and 0·46 ft. wide; it was fastened to the end of a horizontal bar, 5·35 ft. long, the other end of which was planted upon a vertical cylinder movable round its axis. When a motion of rotation was given it, the mill partaking of this motion shocked the air with a velocity which represents that of the wind impinging upon the sails of a common mill, and which has consequently been taken for it. By reason of the shock, the mill turns round its own axis, and, by means of a cord wound round its axle, it raises the weights which serve as a measure of the effect produced.

Smeaton first investigated the best method of weathering the sails; and, with a velocity of 6 ft., he made various experiments, among which were the following:

He first took plane sails, and according to the directions of Parent, he inclined them 35°: a weight of 7·56 lbs. (comprising the resistance of frictions) was raised 2·28 ft. in one minute: thus, the dynamic effect in this time, was . . . . 17·22 lbs. ft.

Of all the inclinations of the plane wings, that of 15° gave the greatest effect, and was . . . 25·18

On inclining the different cross-bars of the same wing, the quantity indicated for each of them by the rule of Maclaurin, that of the end bars being from 32° to 15°, the effect was . . . 28·58

Finally, arranging these bars according to the Dutch method, so that the sail presents a slight concavity to the wind, the greatest effect was when the extreme angles were from 22½° to 7½°; it was then raised to 34·65

By increasing the surface of the sails one-quarter by means of a triangular strip, they had . . . . 44·50

From the various observations upon the mill, as well as from those of great mills, and attributing to the wind its common velocity, when it yields good effects, Smeaton recommends the division of the length of each arm into six equal parts. At the extremity of the first, starting from the centre of rotation, is placed the first cross-piece, inclined 18° to the plane of motion; the inclination of the second is 19°; that of the third (middle of the wing) was also 18°; that of the fourth 16°; that of the fifth 12½°; and at the end of the wing it was only 7°.

Smeaton also thought there was an advantage in making the sails larger at their end by giving them the form of a trapezium with bases as 5 to 3, the greatest of which to be one-third the length of the arm.

556. *Laws of Motion.*—The same author concluded from many other experiments made with velocities of wind from 4·3 ft. up to 8·7 ft.:

* "On the Construction and Effects of Windmills."

1st. That when the sails are most advantageously weathered, and without load, the velocity at their end is four times greater than that of the wind.

2d. That when they are loaded so as to produce a maximum effect, the velocity of the end is not over 2·7 that of the wind: 2·5 times in the mills of Flanders, according to Coulomb.

3d. That, consequently, in the case of greatest effect, and in those in its vicinity, the velocity of the sails is in a constant ratio with that of the wind; it is proportional to it.

4th. That in similar cases, the loads are nearly proportional to the square of the velocity of the wind; thus, the velocities being increased in the ratio of 1 to 2, the loads have increased in that of 1 to 3 75.

5th. That the effects which are in the compound ratio of the loads and velocities, will be nearly as the cubes of the velocities. In these experiments, the effects have a mean increase as 1 to 7·02, the velocities being as 1 to 2. We have already seen that Euler has admitted this ratio of the effects to the cubes of the velocities, and yet, the experiments made in Holland and reported by this geometrician, indicate that they are too great.

Moreover, Smeaton, as well as Euler and other authors, regard the effect as proportional to the surface of the sails (though we have elsewhere shown them to be rather in the proportion of $s^{1\cdot1}$).

557. Admitting the ratios above indicated, as well as a good disposition of the sails, the expression of the dynamic effect of a windmill would be $n\,s\,v^3$; s being the surface of the four sails, v the velocity of the wind, and n a constant co-efficient on the supposition of a mean density of the air. This co-efficient will be given by experiment.

Smeaton reports one where he had $s=2\cdot8062$ sq. ft., $v=8\cdot7501$ ft.; the weight raised was 17·61 lbs., and the height of elevation in 1 sec. ·1019 ft.; and, consequently, the dynamic effect was 1·7894 lbs. ft.; he then had $1\cdot7894=n\times2\cdot8062\times(8\cdot7501)^3$: whence $n=0\cdot00095$. The experiment reported above, where the effect in one minute was 34·65 lbs. ft. with a velocity of wind equal to 6 ft., also gave $n=\cdot00095$. Thus, the experiments of Smeaton indicate for the value of the maximum effect, $\cdot00095\,s\,v^3$.

558. But can a formula based on observations made upon a small model of a mill receiving the action of the wind differently from common mills, be applied with confidence to the determination of the effects of great mills, effects which are two, three, and four thousand times greater? Prudence demands at least a verification made upon one of the great mills. An experiment made by Coulomb, with all the discernment and exactness which characterize the numerous and useful works of this skilful philosopher, causes us to give an account of it.*

In the environs of the City of Lisle, there are a great number of these Dutch mills, whose principal dimensions we have recorded; and Coulomb, observing that the small variations in the disposition of their sails did not occasion variations of effect, concluded that their construction was very near the maximum of perfection. Many of them were used for the extraction of rape-seed, for which purpose their shafts have cams which raise

* *Observations sur l'Effet des Moulins a vent*, in the *Memoire de l'Academie des Sciences*, year 1781.

up the great pestles. In the experiment just mentioned, when the velocity of the wind was 21·3 ft., six pestles, weighing in all 6044 lbs., were each raised 26 times in one minute 1·59 ft.; consequently, the useful effect in one second, was . 4186 lbs. ft.

The friction, from a special observation to determine it, consumed a quantity of motive action equal to . . 354·5

The loss of *vis viva* occasioned by the shock of the cams against the ears of the pestles, was estimated at . . . 316·2

In all, for the dynamic effect, . . 4856·7

Moreover, $s = 873{\cdot}2$ sq. ft.; thus, $4856{\cdot}7 = n \times 873{\cdot}2\ (21{\cdot}32)^3$; whence we derive $n = 0{\cdot}00057$.

559. This value of n would give smaller effects than those indicated by the experiments of Smeaton, in the ratio of 3 to 5. Though I do not doubt the exactness of the observations of the English Engineer, still as those of Coulomb were made upon mills more similar in their disposition and magnitude to those for which the formulæ are applicable, I believe the preference should be given to their results, the rather that in estimating the effect of machines, an error below the reality does not occasion any serious result in practice. We shall then establish for the general expression of the dynamic effect of windmills, 0·00057 lbs. ft. $s\,v^3$.

Finally, we only admit this formula as furnishing a simple approximation; for it is doubtful after what has been said whether their effects are exactly proportional to the surface of the sails, and the cubes of the velocities.

This expression is of the same kind as that giving the effect of mills placed upon rivers, which we have seen to be $0{\cdot}400\ s\,v^3$ (333). In the last case, the wheels move in an indefinite fluid; but here, the fluid being about 800 times less dense, its action will be 800 times less, and the effect would not be over $\cdot 0005\ s\,v^3$; an expression whose co-efficient is still smaller than that indicated by the observations of Coulomb.

560. *Economical Effect.*—We have admitted that to grind a hectolitre (2·75 bushels Imp.), there must be impressed upon the mill-stone a force of two horse-powers, or of 1085 lbs. ft. in 1 sec. Though the above force, 0·00057 lbs. ft. $s\,v^3$, was measured upon the shaft, and must have experienced a slight diminution in its passage to the stone, we may preserve it as it is; and it will indicate, for the quantity of corn which a windmill can grind in one hour, at most

$$\cdot 0000005\ s\,v^3 \text{ hect.}$$

Coulomb states that the mills of Flanders, with a wind of 19·2 ft. velocity, yield from 5·2 to 5·8 hectolitres per hour: such a product, which seems large to me, would advance the economical effect, as a mean, to $0{\cdot}00000085\ s\,v^3$.

*Removing Scale from Boilers.**

A series of important experiments have, during the past eight months, been carried out at Portsmouth on board Her Majesty's paddle steamer *Wallace*, under the supervision of Mr. G. Murdock, inspector of machinery afloat at that port. The object sought to be attained, is the removal of the scale generated on the surface of steam boilers and their tubes, by other and more expeditious means than by

* From Mitchell's Steam-shipping Journal, Dec., 1860.

the present system of manual labor. The importance of the subject will be fully comprehended by all who may be in the slightest degree conversant with steam machinery. Under the present system, should a ship's boilers require cleaning out, or clearing from scale, while on board the ship, all the boiler doors have to be taken off and a number of men sent into the boilers to clear the scale by manual labor. By these means, with the greatest exertions and any amount of time, possibly 10 per cent. of the scale might be removed, and with this small improvement the engineer well knows the relief he finds in getting steam. By the system which has now been undergoing so long a series of tests on board the *Wallace*, only one door of the boiler has to be taken off to allow the introduction of the steam pipe. The boiler to be acted upon is then filled rapidly with superheated steam at a temperature of 400° of heat; this acting upon the saline deposits on the surface of the tubes, and other parts of the boiler, expands and disengages it from the several parts. After this, the boiler is again filled with water, and steam got up in the usual manner, and kept up for a few hours, and on afterwards blowing off the boilers, they are found to be as free from scale as when they were first put on board the ship. The experiments have been highly successful. The saving of fuel alone in our steam ships of war from adapting this plan to their boilers, will be very considerable, and the whole scale may be removed from a ship's boilers in 12 hours. A very remarkable specimen of scale may be seen in the chemical laboratory in Portsmouth Dockyard, which was removed from the boilers of Her Majesty's ship *Sidon* when under the command of Sir Charles Napier. The impression of the tubes on the scale is perfect.

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*Wright's Method of Preventing Boiler Explosions.**

Mr. E. T. Wright, Engineer, of Wolverhampton, has just patented the method of preventing boiler explosions by connecting a water buoy or float in the steam boiler with the furnace or door, with a door opening into the furnace, so that when the water in the boiler falls below a given level the door is opened, and cold air is admitted into the furnace, "whereby the boiler is cooled, and the draft through the fire to a great extent suspended; the overheating and consequent danger of explosion of the boiler is thereby prevented, and the attendant on proceeding to fire is warned of the state of the water in the boiler by the open door." The inventor sometimes connects the float in the boiler with the furnace door by means of a chain and pulley, as illustrated in the engravings, Figs. 1 and 2; *e* is the float hung to the lever *f* in the boiler. The said lever *f* turns upon a fulcrum at *g*; a chain *h* passing over the pulley *i* connects the float *e* with

*From the Lond. Practical Mechanics' Magazine, May, 1859.

the furnace door *k*. By the descent of the float *e* the furnace door *k* is raised. In boilers of the kind represented, the distance between the water level and the furnace flue is sometimes insufficient to allow of the descent of the float through the requisite distance when the said float is immediately over the said flue. On this account the float is placed on one side as shown.

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*On the Weight and Strength of American Ship-timber.** By DONALD McKAY, Ship-builder, of Boston, U. S.

WEIGHT OF A CUBIC FOOT OF

	Virginia White Oak.		Virginia Yellow Pine.†	
	Round.	Square.	Round.	Square.
	lbs.	lbs.	lbs.	lbs.
After felling, . .	64·74	67·20	47·81	39·21
1 year after, .	53·60	53·51	39·83	34·16
4 years after, . .	45·97	49·89	34·28	33·49

Each of the above numbers are the mean of experiments on twelve different pieces of timber cut from different trees, and the experiments were made by Mr. Farris, Timber Inspector of Gosport Navy Yard.

WEIGHT OF A CUBIC FOOT OF LIVE OAK, ACCORDING TO GRIFFITH.

Green, . . 78·69 lbs. | Seasoned, . . 66·75 lbs.

This timber is exclusively used for the frames of the United States men-of-war ships, and is considered by all naval men to be almost imperishable.

TENSILE STRENGTH OF AMERICAN WHITE OAK AND ENGLISH OAK PER ONE SQUARE INCH.

(*From "Appleton's Dictionary of Mechanics."*)

English Oak, 8820 to 10,224 lbs. American White Oak, 11,501 lbs.

SPECIFIC GRAVITY AND TRANSVERSE STRENGTH (PER ONE SQUARE INCH) OF ENGLISH OAK AND AMERICAN WHITE AND LIVE OAK.

(*According to various observers.*)

Extracted from a Table published in Vol. V. of the Professional Papers of the Royal Engineers.

Name of Observer.	English Oak.		American White Oak.		American Live Oak.	
	Spec. gravity.	Strength.	Spec. gravity	Strength.	Spec. gravity	Strength.
		lbs.		lbs.		lbs.
Lieut. Nelson, .	834	1629	645	1699	1160	1863
Mr. Moore, . .	816	1919	836	1699		
Mr. Barlow, . .	934	1672	872	1766		
Lieut. Dennison,	733	1556	772	1809		
Mean results, . .	829	1694	781	1743	1160	1863

According to these experiments, the advantage of lightness, combined with strength, is entirely on the side of American White Oak.

*From the Lond. Mechanics' Magazine, Dec. 1859.

†The Virginia Pitch Pine is called in America "Yellow Pine." The Florida Yellow Pine is called the "Long-leaf Yellow Pine," and weighs about 41 lbs. per cubic foot.

For the Journal of the Franklin Institute.

Particulars of the Steamer Benjamin Déford.

Hull and machinery built by Harlan & Hollingsworth & Co., Wilmington, Del. Intended service, Bahama to Savannah.

Hull.—

Length on deck, from fore part of stem to after part of stern post, above the spar deck, . . 214 feet.
Breadth of beam at midship section, . 33 "
Depth of hold, . . . 15 " 6 inches.
" to spar deck, . . 23 " 4½ "
Frame—of wrought iron.
Floors, |; molded, 4 ins.—sided 1½ ins.; and 16 and 18 ins. apart at centres.
Plates—7-16 to 13-16 in. thick.
Draft of water at load line, . . 12 "
" below pressure and revolutions, 10 "
Area of immersed midship section at this draft, 280 sq. ft.
Tonnage, custom house, . 1090 14-95.
Contents of bunkers in tons of coal, . 130.
Masts and rig—Brigantine.

Engine.—Vertical beam.

Diameter of cylinder, . . 56 inches.
Length of stroke, . . . 11 feet.
Maximum pressure of steam, . 25 lbs.
Maximum revolutions per minute, . 19.
Cut-off—one-half.
Weight of engines, . . 280,000 lbs.

Boiler.—One—Return tubular.

Length of boiler, . . . 16 feet.
Breadth " . . . 16 " 6 inches.
Height " exclusive of steam chimney, . 12 " 9 "
Weight " with water, . 140,000 lbs.
Number of furnaces, . . 4.
Breadth " . . . 3 " 8 "
Length of grate bars, . . 7 " 6 "
Number of flues, below, . . 4 arches.
" tubes above, . . 212.
Internal diameter of tubes, . . 4 "
Length of tubes, . . . 11 "
Heating surface (fire and flue), 3222 sq. ft.
Diameter of smoke pipe, . . . 5 " 3 "
Height " . . . 55 "
Description of coal, Bituminous or Anthracite.
Combustion, Natural draft.

Paddle Wheels.—

Diameter, ... 30 feet.
Length of blades, . . . 7 " 6 inches.
Depth " . . . 19 "
Number " . . . 26.

Remarks.—The *S. R. Spalding*, lately built for the Merchants and Miners' Transportation Co., and running from Baltimore to Boston, is a sister built vessel to this. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer Austin.

Hull and machinery built by Harlan & Hollingsworth & Co., Wilmington, Del. Intended service, New Orleans to Brazos.

Hull.—		
Length on deck, from fore part of stem to after part of stern post, above the spar deck,		203 feet 6 inches.
Breadth of beam at midship section,		34 "
Depth of hold,		10 "
" to spar deck,		17 " 9 "
Frames—of wrought iron.		
Floor, |; molded, 3½ ins.—sided, ⅞-ins.; and 16 and 18 ins. apart from centres.		
Plates—½-in. to 5-16 in. thick.		
Draft of water at load line,		7 " 6 "
" below pressure and revolutions,		6 " 6 "
Area of immersed section at this draft,	190 sq. ft.	
Tonnage, custom house,	642 77-95.	
Contents of bunkers in tons of coal,	260.	
Masts and rig—Schooner.		
Engine.—Vertical beam.		
Diameter of cylinder,		44 inches.
Length of stroke,		11 feet.
Maximum pressure of steam,	25 lbs.	
Maximum revolutions per minute,	17.	
Cut-off—half-stroke.		
Weight of engines,	230,000 lbs.	
Boiler.—One—Return flue.		
Length of boiler,		24 feet.
Breadth "		15 " 6 inches.
Height " exclusive of steam chimney,		9 " 2 inches.
Weight " with water,	120,000 lbs.	
Number of furnaces,	3.	
Length of grate bars,		6 " 2 "
Number of flues,	above, 8—below, 8.	
Length of flues, above,		19 " 2 "
Length of flues, below,		15 " 6 "
Heating surface (fire and flue),	1880 sq. ft.	
Height of smoke pipe,		50 "
Description of coal,	Bituminous or Anthracite.	
Combustion,	Natural draft.	
Paddle Wheels.		
Diameter,		30 feet.
Length of blades,		6 " 6 inches.
Depth "		22 "
Number "	26.	

C. H. H.

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*Permanent Building.—Fall of Houses in Salford.**

During Sunday last two accidents to dwelling houses occurred in Salford, but fortunately they were not attended by personal injury. About three o'clock in the morning, the front wall of a two story house in Cross-street, Bury-street, fell with an alarming crash, and rendered the place a ruin. The second accident occurred in Queen-street, soon

* From the Lond. Builder, No. 384.

after two o'clock on Sunday afternoon. A laboring man, named Jones, was about to sit down to dinner with his family in the upper front room of a cottage house in that street, when there came a loud crack, followed by two others, and a noise "like thunder" as the neighbors declare. The wood-work of the roof had yielded, and the whole mass dropped inward, until it bore upon the top of a large four post bed in the middle of the room.

Translated for the Journal of the Franklin Institute.

On Giffard's Automatic Injector for Steam Boilers.

By M. Ch. Combes, Inspector-General; Director of the *Ecole des Mines. Annales des Mines, 5th Series, Vol.* XV, *p.* 169.

The attention which this ingenious instrument for the water-supply to steam boilers has attracted in France, but more especially the merits of the description and theory of M. Combes, has induced us to lay this memoir before our readers; hoping to attract the attention of our young mechanics and engineers to the beauty and advantages of the French method of precise analysis of every machine. ED. J. F. I.

The apparatus recently invented by M. Giffard for feeding steam boilers, has justly attracted the attention of engineers by its originality. Already quite a number of applications of it have been made, both to the boilers of fixed engines and locomotives. It seems to me that it will be useful in publishing the description of it, to add some reflections or general explanations. I shall perhaps be able to complete them hereafter by the results of experiments which will be its natural and almost necessary complement. In the meantime, they will suffice to explain the action of this ingenious apparatus, and may be useful in deterring some persons with imperfect ideas of mechanics and physics, from attempting irrational applications of the natural phenomena of which M. Giffard has taken advantage with as much skill as discernment.

The steam boiler injector of M. Giffard contains no solid movable parts; it is founded upon the principle of the lateral communication of motion in fluids. The figure (Plate IV) presents a section of the apparatus by a plane passing through its axis. L is a tube through which the steam comes from the boiler, the discharge of which may be checked or entirely stopped by means of the stop-cock R. The steam penetrates by a number of openings into the interior of a cylinder, *c*, which terminates in a cone opening by a small circular orifice. A solid cylindrical rod, *t*, occupying the axis of the cylinder, is terminated by a conical point which may be pushed gradually into the ajutage which surrounds it, so as to change by degrees the size of the annular space by which the steam escapes. The rod *t* is moved forwards or backwards by means of a screw, the nut of which is fastened into the end of the cylinder opposite to the conical ajutage, and of a small winch on the outside, *m*. The steam issuing from the cylinder *c*, jets into

the interior of a short cone, broader than the conical ajutage of the cylinder, the end of which it surrounds, leaving between them a free annular space. In front of this second cone is the hollow space E, to which is applied the tube T, the end of which is plunged under the surface of the cold water contained in a vessel which may be placed 1 or 2 metres below E. The screw V, with its winch *n*, permit a change of the depth to which the conical ajutage of the cylinder *c* is inserted into the broader cone *d*. The figure will show how by turning the screw which takes into a nut firmly attached to the external envelope of the cylinder *c*, a slow movement in the direction of its axis is given to this cylinder and all the parts connected with it. When the steam jets through the terminal orifice of the ajutage of the cylinder, it draws with it the air contained in the cone *d* and the space E, into which the water soon comes through the pipe T. This water mixes with the steam and condenses it, and a jet of water issues from the orifice of the cone *d* with a velocity which depends on that which the steam had at its issuing from the cylinder *c*, and on the quantity of water drawn in. Exactly in front of the orifice by which the water jets, at a distance of 1 centimetre at most, is the orifice of another very much elongated cone, I, the axis of which is in the prolongation of the common axis of *c* and *d*, but the orifice of which is bored out in the opposite direction. The liquid vein issuing from the cone *d* thus jets directly into the interior of the cone I. This communicates with the boiler by the pipe L; and in the passage is interposed a valve or clack S, opening towards the boiler. This clack is shut when the apparatus is not in action, by the excess of the pressure in the boiler over that of the atmosphere. When the apparatus is working, and well-adjusted, the jet enters entirely into the cone I, and all the water passes into the boiler, forcing a passage through the clack S. The space E which exists around the extremities of the two opposed cones, *d* and I, communicates freely with the atmospheric air by circular openings, O O, which permit the water to be seen as it passes from the cone *d* to I. The vein is always opaque and troubled, either because the steam is not all condensed, or because a little air is drawn in with the water. The pipe T is for the purpose of discharging the cold water which may be drawn in in excess before the apparatus is in adjustment, and that which is formed by the condensation of the steam when the apparatus is first put into action; it opens into the atmosphere, and discharges these waste-waters into the reservoir of cold water.

The feeding by means of the Giffard injector is intermittent. The apparatus is put in action by opening the stop-cock R which allows the steam to come from the boiler. The quantity of steam expended may be altered, by thrusting the rod *t* more or less into the conical ajutage, and the quantity of feed-water is governed by plunging the conical ajutage more or less deeply into the cone *d*. The adjustment is easily and quickly made.

A cubic metre of saturated steam at the temperature of 152°, and under a pressure of 5 atmospheres or 5·165 kil. per square centimetre,

weighs (its weight being calculated by the laws of Mariotte and Gay-Lussac) 2·5962 kil. If we admit that the steam of this density and pressure (maintained constant) flows from the vessel which contains it into the atmosphere by an orifice, keeping its density as a liquid would, its velocity of issue would be (omitting the resistances occasioned by the form of the orifice) $\sqrt{2g\frac{\text{P}-p}{q}}$, where g denotes the gravity, P and p the respective pressures of the steam and the atmosphere upon the unit of surface, and q the specific gravity of the steam. On the assumptions above $\frac{\text{P}-p}{q}=15{\cdot}916$. But $g=9{\cdot}8088$; the velocity of issue of the steam would, therefore, be in the case assumed, 558·79 metres per second; and the height due to this velocity 15,916 metres.

If we suppose that, owing to the form of the vessel orifice or steam-tube, or to any other circumstances, the steam dilates before it reaches the orifice, so as to pass it with a density corresponding to the atmospheric pressure, its temperature being kept constant during the dilatation taking place in the interior of the vessel, the velocity of issue will be, in this case, given by the expression

$$\sqrt{2g\frac{p}{q}\text{ hyp. log. }\frac{\text{P}}{p}},$$

where q expresses the specific gravity of the steam under atmospheric pressure at the temperature of 152°, P, p, and g having the same meaning as before. Now $q=0{\cdot}519$ k.; $\frac{\text{P}}{p}=5$; $\frac{p}{q}\ \frac{10330}{0{\cdot}519}$. Introducing these numerical data into the formula, we find for the velocity of the steam issuing under atmospheric pressure 792·82 m. per sec.; the height corresponding to this velocity is 32,044 metres.

This indicates that the vapor at its issue has a velocity in virtue of which its particles considered as isolated and without action on each other, would ascend to a height of 15,916 or 32,034 metres, in vacuo, according as the steam had kept all its density and pressure or had been dilated in the pipe from 5 to 1 atmosphere. In other words the living force which the steam has at its issue corresponds to a quantity of work equal to the weight of the steam falling through a height of 15,916 or 32,034 metres according to the hypothesis we take; and this work is the theoretical work due to the steam, according as it acts with full pressure and without condensation against the external atmosphere, or acts by expanding from 5 to 1 atmosphere; its initial temperature being maintained during the expansion.

This being established, the steam immediately after passing into the atmosphere meets with water which suddenly condenses it, and forms with it a jet which is completely liquid. The velocity of the water which condenses the steam may be neglected in comparison with that of the steam itself, and the internal reaction which cause the condensation cannot modify the quantity of motion. If then we designate

by m the mass of the steam which flows out in the unit of time, by M the mass of the water, which mixes with this condensed steam to form the liquid jet, by v the velocity of issue of the steam, by u the velocity of the jet after condensation, we have $u = v\,\frac{m}{m+M}$. The mass of the water must be sufficient to accomplish the entire condensation of the steam. Let the temperature of the water be 15°, we may, as an approximation, admit that the steam in condensing abandons 550 units of heat. If it is desired that the liquid jet should be at the temperature of 60° the ratio of M to m will be established by the equation $15\,M + 650\,m = (m+M)\,60$; whence $M = 13{\cdot}11\,m$. The weight of the water, therefore, under the condition assumed above, must be about 13 times that of the steam.

Admitting the weight of the water to be 15 times that of the steam, the temperature of the liquid jet will be found to be 57° or 58° (the water being taken at the temperature 15°). Let, then, $M = 15\,m$; the velocity of the jet will be $\frac{1}{16}$ of that of the steam, and the height to which it will rise in virtue of this velocity will be $\frac{1}{16^2}\cdot\frac{v^2}{2g}$, while the isolated particles of the steam would have risen to the height $\frac{v^2}{2g}$. But the weight of the liquid jet being 16 times that of the steam, its living force is $\frac{1}{16}$ of that of the steam before its condensation.

The velocity of the liquid jet being $\frac{1}{16}$ of that of the steam will be comprised between the limits 34·92 and 49·55 metres per second. If it be greater than that with which water at the temperature of the jet would spout from the boiler into the atmosphere, under an interior pressure of five atmospheres; it is evident that the liquid jet driven into an ajutage of proper form communicating with the interior of the boiler, will enter the boiler driving back the water which tends to escape. Now if neglecting the effect of the dilatation of the water between 3° and 58°, we assume 1 kil. as the weight of 1 litre of the water of the jet, we shall have for the velocity with which the water at this temperature will tend to pass from the boiler into the atmosphere 28·37 metres. A velocity so far below the lowest limit which we found for the jet, that we may regard as certain, the possibility of forcing into the boiler with the steam which has issued from it a weight 15 times greater than that of this steam. The water at its entrance will have a temperature of about 57°.

It will be seen that the jet could not enter the boiler if its velocity fell as low as 28·37 metres per second. Now this would happen with a weight of water equal to $\frac{558{\cdot}79}{28{\cdot}37} - 1 = 18{\cdot}7$ or $\frac{792{\cdot}82}{28{\cdot}37} - 1 = 27{\cdot}9$ times the weight of the steam, according as the steam at the moment of mixing with the water, is supposed to have a velocity of 558·79 or 792·82 metres per second. It is pretty certain that the velocity of the steam is much nearer the first limit than the second; and if this

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if this

be really so, the quantity of water which it is possible to introduce into the boiler by means of the injecting apparatus, will be at the greatest 18 times the weight of the steam used in the apparatus.

The volume of feed-water which it is possible to drive into the boiler by means of M. Giffard's injector increases in proportion as the effective pressure (that is, the excess of the pressure of the steam over that of the atmosphere) increases. Thus, for instance, if the effective pressure is only half an atmosphere, the weight of the cubic metre of steam under that pressure and the corresponding temperature 111° will be 0·8349 kil. The formula gives in this case, for the velocity of the steam issuing into the atmosphere without previous expansion, 332 metres per second. The velocity with which the liquid water would spout under a pressure of half an atmosphere, would be only, in round numbers, 10 metres per second; whence it follows that the steam could draw with it 30 times its weight of water, the liquid jet still preserving sufficient velocity to penetrate into the boiler. The limit thus roughly determined is undoubtedly too high, because, on the one hand the velocity of the steam is diminished by the resistances of the pipes and ajutage, and on the other hand the density of the liquid jet is diminished by the rise of the temperature, perhaps by imperfectly condensed steam, and by the air drawn in. But it is nevertheless certain that the feed will be more certain and may be made more abundant in proportion as thé effective pressure in the boiler is less.

As an apparatus for feeding steam boilers, the injector of M. Giffard is without doubt the best of all those hitherto employed, and the best that can be employed, as it is also the most ingenious and simple. If, in fact, in conformity with the old ideas, we suppose that the quantity of heat contained in bodies is preserved integrally; then, whatever changes of volume or state they undergo, independently of the quantity of work done, or of resistances which are the consequences of these changes, it is clear that the action of the Giffard apparatus will give occasion to no loss of heat except that which will take place by radiation, or by contact of the boiler and its appurtenances with the surrounding air. The feeding will then be gratuitous.

If, conformably to the more rational principles of the new dynamic theory of heat, we admit that the heat is transformed into work, and *vice-versa*, so that all the work or resistances, all the living forces, developed or destroyed in the changes of volume or state of bodies, are accompanied by a disappearance or production of an equivalent heat; the quantity of heat expended in the Giffard apparatus will be precisely (neglecting the losses by radiation and contact with surrounding mediums,) equivalent to the quantity of work corresponding to the elevation of the feed-water from the reservoir whence it is taken, and its forcing into the boiler against the pressure which exists there. We are therefore authorized to assert that the apparatus of M. Giffard as a feed-pump for boilers, is theoretically perfect. But machines constructed on the same principle as this apparatus, for the elevation of water, or more generally for the purpose of moving masses of liquids or gases, so that the heat contained in the jet formed by the mixture

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of the steam and the liquids or gases drawn in by it, would be of no use in the final effect, would be very poor machines as regards the economy of work. Thus we have seen that if the steam draws in with it n times its weight of water or any other fluid, the living force of the jet is reduced to the fraction $\frac{1}{1+n}$ of the living force which the vapor had at first, so that the living force lost is the fraction $\frac{n}{n+1}$ of the primitive living force. This loss increases enormously with the ratio of the weight drawn in to the weight of the steam, and this ratio would generally be very great.

A jet of steam issuing with a velocity due to a pressure of 5 atmospheres, can draw with it 50 times its weight of water and lift it to a height which in round numbers would be nearly 6 metres. The loss of work in this case would be $\frac{50}{51}$ of the total work which the steam could have developed had it acted with full pressure without expansion or condensation, against the external atmosphere.

If a jet of steam with the velocity here supposed, draws in 10 times its weight of atmospheric air, acting thus as a blowing-machine, the living force of the jet of damp air would not exceed $\frac{1}{11}$ of the living force of the steam; that is, the work which would have been theoretically performed by the steam acting against the pressure of the atmosphere, without condensation.

The apparatus of this kind which are now and may hereafter be used, may, no doubt, be advantageously employed under peculiar circumstances, owing to their extreme simplicity; but they not the less remain very bad machines in reference to the economy of motive power.

M. Giffard perfectly well understood this. The merit of his ingenious invention therefore consists in its application to steam boilers, and the construction of an apparatus which works with perfect ease and regularity: which, for example, at the Imperial Tobacco Manufactory, where it suffices for the feed of boilers of 200 horse-power, injects per hour, as we have been told, as much as 4 cubic metres (*tons*) of water.

Some persons have claimed the priority of invention over M. Giffard. If they have not made use of the steam-jet from a boiler for the feed of that same boiler, or realized other applications in which the heat contained in the jet drawn in by the steam plays the principal part, they have, in our opinion, made but bad machines, founded on a fact long known and applied, viz: the drawing along of gases or liquids by lateral communication.

The Giffard Injector has been applied for a month past to a locomotive on the Paris-Strasbourg railroad. At first the feed-pumps were left in place, so that they might be used in cases of necessity; but there was no occasion to have recourse to them, and after it was ascertained that the working of the injector was easy and sure, the pumps were removed two weeks since.

The Injector is placed horizontally and fixed by two iron clamps

upon the left side of the boiler; the winches of the two screws, *m* and *n*, are turned towards the rear, so as to be near the driver; the space surrounding the conical ajutage of the cylinder which receives the steam, is put by a pipe into communication with the tender. The conical tube, I, which receives the liquid jet, enters a vertical cylindrical box containing the clack S, which is placed above the point of insertion of the pipe into the box. Above the clack is inserted the pipe which opens into the boiler near the lower and front part, at the same point where the feed-pipe from the pump was formerly inserted. The cylindrical box is closed above by a plate fixed by a stirrup and screw, so that the clack is easily accessible, even while the machine is in motion. The cylindrical box which unites the two parts of the apparatus, opens into the atmosphere, and along its axis the liquid vein can be seen passing from the injecting into the receiving cone; it is furnished at its lower part with a short tube, by which the water drawn in, when it has not been entirely received into the cone I, is discharged; it falls under the eye of the observer into a funnel whence it may be re-conducted into the tender. When the apparatus is not in action, the stop-cock of the steam-pipe is closed, and the rod, *t*, is pushed into the ajutage. When the engine-driver wishes to feed, he first opens the stop-cock, the steam enters the cylinder which it heats up by its own partial condensation, but it cannot escape owing to the position of the rod; this is withdrawn by turning the winch of its screw immediately after the opening of the stop-cock. The water from the tender is immediately drawn in; the whole of that which comes in does not at first penetrate into the receiving cone: a part flows off by the waste-pipe. In order that this discharge may cease, and that the whole of the water drawn in may penetrate into the receiving cone and thence into the boiler, the conical ajutage of the cylinder, *c*, must be properly inserted in the exterior cone. The depth of the insertion, which is regulated by the driver by means of the screw and winch *n*, must be greater and the annular space through which the water passes consequently narrower, as the pressure is less in the boiler. Thus, for example, if, at the moment the apparatus is set to work, the steam gauge of the boiler indicates 7 atmospheres, and the ajutage has been so adjusted that the whole liquid jet penetrates into the receiving cone, and no water escapes by the discharge-pipe, this latter pipe will show water so soon as the gauge indicates a perceptibly lower pressure, and the more the pressure falls the greater the quantity of water wasted. To stop this waste, it is necessary to push the ajutage farther into the external cone in proportion as the pressure falls; the effect of this adjustment is so sensible that the engine-driver informed me that he could tell the pressure in his boiler as well by the amount of adjustment necessary to stop the waste, as by reading the gauge. When it is desired to feed by the Injector, a locomotive at rest, before its steam is up, the interior pressure being, for instance, not more than 1½ or 2 atmospheres, the ajutage must be pushed very far into the cone, and for this purpose it is necessary to make several revolutions of the screw V; the winch ought therefore to be so adjusted that this may be easy.

This is not the case in the locomotives on the Eastern Railroad; the winch not being able to make an entire revolution, the driver is obliged to remove and replace it on its square, when he wants to feed before his steam is up.

It is evident that by contracting the annular space between the ajutage and the cone through which the water drawn in passes, the volume of this water is diminished. The facts which I have just mentioned, are not at variance with that which I said as to the greater ease of feeding a boiler by the Injector in proportion as the internal pressure diminishes; the weight of the steam expended in the unit of time diminishes much more rapidly in the compound ratio of the decrease of the velocity and density. The quantity of water mixed with the steam and thrown into the boiler in a unit of time, must therefore decrease with the internal pressure, although the ratio of the weight of this water to that of the steam, increases. Now, as this quantity of water flowing in in the unit of time depends principally upon the size of the annular space between the exterior wall of the ajutage and the interior of the surrounding cone, it is easily seen that this space must be contracted in proportion as the pressure in the boiler diminishes.

The Academy of Sciences, of Paris, have awarded to this Injector the Montyon Prize of 1000 francs, "for the most deserving invention of instruments useful to agriculture, the mechanic arts, or sciences."

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*Notices of some of the Patents taken out for the preparation and use of the new Purple Dyes generally known as the "Mauve or Perkins' Purple, Harmaline, Violine, Purpurine, Roseine, &c.," with Remarks upon them.**

The superb and fast purple colors obtained by the action of bi-chromate of potash on aniline and its homologues, was discovered by Mr. W. H. Perkins. Dr. Hofmann's researches on aniline were doubtless the true cause of attention being drawn to that base as a substance from which results of practical importance were one day to be obtained; and in the hands of his pupil, the manufacture of aniline purple has become one of the most refined and beautiful manufactures known.

The tendency of aniline to yield colors when subjected to various processes of oxidation has long been known. Solutions of salts of aniline with the mineral acids when evaporated, generally color the edges of the basins of a red or blue tint. The power of a solution of bleaching powder to develop a charming purple tint in even the weakest aqueous solution of aniline has for many years been known, and applied in the examination of organic bases as a test for the presence of that alkaloid. This reaction has been seized upon as the foundation of a patent granted to Joshua Taylor Beale and Thomas Nesham Kirkham, dated May 13th, 1859. The following quotation from the specification will give a sufficient idea of the nature of the process:

"As examples of some of the more desirable modes of producing the improved dye according to our invention, we give the following proportions and modes of operating:—

* From the Lond. Chemical News, No. 7.

We take one measure of aniline water saturated, and add thereto one measure of acetic acid, say of five strengths, and one measure of hypochlorite of lime, of, say, specific gravity 1010. The hypochlorite should be carefully added, in order to admit of producing the particular shades of violet blues required, as shades of varying depth may be produced by increasing or decreasing the proportion of the hypochlorite. After a while the dye will become lilac, and will dye lilac of various intensities, depending on the quantity of hypochlorite of lime and water that may be mixed with the dye. Instead of adding a solution of chlorine or hypochlorite of lime to the liquor, we sometimes pass chlorine gas through the latter, carefully watching the same during the process, in order to arrest the further supply of the gas when the desired effect has been produced on the liquor."

With reference to the above we consider that any process founded upon the action of hypochlorite of lime upon aniline must be of limited application. In the first place, the presence of the bleaching powder would render it impossible for the fabric previously dyed with fugitive colors to be passed through the bath. In the next place, it would interfere in many cases with the subsequent application of other colors. But there is a more serious difficulty owing to the sparing solubility of aniline in water, consequently the dye will always be in a very dilute state, and totally useless in practice as compared with the highly concentrated solution sold by Mr. Perkins, at £6 the gallon. In the next place, even the small quantity of aniline which exists in solution will not be totally converted into dye, so that enormous volumes of fluid, involving correspondingly large vessels, will have to be employed to obtain a comparatively minute quantity of dye.

Several patents, besides that last mentioned, have been taken out for producing aniline purple. Among the substances used to oxidize the aniline may be mentioned peroxide of lead, peroxide of manganese, and the green manganate of potash.

As regards the manganese and peroxide of lead, there are two patents for the use of these substances. The first, dated May 7th, 1859, was granted to Richard Dugdale Kay. The last named patentee takes an acetate, sulphate or hydrochlorate of aniline, with excess of acid, and treats the salt with peroxide of manganese at a temperature of 212° F. until no further precipitate is obtained. The patentee also claims peroxide of lead or chloride of lime as oxidizing agents. In this process a precipitate and liquid are obtained, both of which contain coloring matter; the latter is obtained from the precipitate by digestion in dilute sulphuric acid. The liquids are then mixed together, and the coloring matter and manganese precipitated by ammonia. The precipitate is then washed and dried, and the coloring matter extracted by weak alcohol or methylated spirit.

This patent does not give any process for separating the brown or resinous impurities which accompany the coloring matter, except by so reducing the strength of the spirit as to prevent it dissolving the former. We were aware long before seeing this patent that peroxide of manganese could be used for producing the color, but the experiments made upon the subject by a distinguished Scotch chemist were, as we were informed, by no means satisfactory either as regarded the quantity or quality of the product. If the author of this process can substantiate his claim to the chloride of lime and peroxide of lead processes, he plainly takes the wind out of the sails of the patents

granted to Beale and Kirkham on the 13th, and David S. Price on the 25th of May, 1859. The latter chemist in his provisional specification claims peroxide or sesquioxide of manganese, but in his final specification he does not mention the manganese, but confines himself to the lead process. Mr. Price, by oxidizing aniline and its homologues with peroxide of lead, prepares three colors which he terms "Violine," "Purpurine," and "Roseine." For these he uses the following proportions of the ingredients:—

VIOLINE.—1 equivalent of aniline, 2 equivalents of sulphuric acid, 1 equivalent of peroxide of lead.

PURPURINE.—2 equivalents of aniline, 2 equivalents of sulphuric acid, 1 equivalent of peroxide of lead.

ROSEINE.—1 equivalent of aniline, 1 equivalent of sulphuric acid, 2 equivalents of peroxide of lead.

The substances are boiled together and filtered hot. The coloring matters are contained in solution. The two first processes do not convert all the aniline into coloring matter, the last does. It is evident, therefore, that the redness of tint increases with the extent of the oxidation. This is quite in accordance with what has been observed generally with the colors from aniline and its congeners. We must admit that while Price's patent appears the most practical of the three, we do not think his process by any means approaching in value to that due to the talent of Mr. Perkins. It is true that the colors would be yielded of considerable purity, but the expense of the peroxide of lead would be very great, and the yield probably small. Moreover there are considerable difficulties in manipulating with so dense a powder as peroxide of lead. All the machinery for agitation must be strong and kept ceaselessly in motion, or so heavy a precipitate would sink to the bottom and produce no result.

The process of Mr. Perkins has none of the disadvantages of any of the others; it is simple, practical, and yields an invariable product. It is true that it is said to require expensive and complex machinery in order to carry it out effectively; but as long as a process contains within itself the elements of success (which we do not think these new patents do), a little expense in the construction of machinery is of comparatively little moment where the final product is so valuable.

Williams's patent is for the use of the green manganate (or, as it is often incorrectly called in commerce, permanganate) of potash as the agent of oxidation. The product when the operation is properly conducted, is unexceptionable in purity and beauty. If the action be too much prolonged the color is entirely changed, and a beautiful pink or crimson color results. In fact, according to the specification, a certain amount of the pink color is always produced. In carrying out this patent, the only thing to be considered is the price of the manganate and the quantity of the product. Upon this point we are not in possession of sufficient information to speak positively.

In using these dyes much depends upon the proper selection of the mordants. Tin is the only metal which has yielded unexceptionable results. The perchloride does very well, but stannate of soda is pre-

ferred. In printing, the dye is first mixed with gum, and the colored mucilage is subsequently stirred up with the desired quantity of albumen. The printed fabric is then steamed in order to fix the color.

Messrs. W. H. Perkins and Mathew Gray (the former the discoverer of the purple, and the latter the skilful director of the great printing establishment at Dalmonach near Glasgow,) have taken out a patent for a new method of mordanting for the purple. They effect this by means of oxide or carbonate of lead. The acetate of lead is first printed on, and the fabric is afterwards passed through a bath of ammonia, or an alkaline carbonate. By this means the lead becomes fixed in the fibre of the cloth. The purple dye bath should then yield its color to the mordanted portions, to the exclusion of the other. But it is found in practice that the patterns printed in this manner are not sharp or well defined. The purple runs into those parts of the cloth which should remain white. To prevent this the goods are washed with soap and water after the fixation of the lead, before subjection to the bath; this clears the whites to some extent, but the patentees sometimes add soap to the bath itself, so as to purify the whites. But if the quantity of soap employed at first to wash the mordanted cloth has been in the proportion of one pound to twenty-five yards of cloth, they do not put any amongst the color in the bath.

It is evident that this process contains within itself sources of error. By the necessity for soaping after the mordanting, it appears that the lead does not adhere with sufficient firmness to the spot where it has been printed on; the soap is therefore to remove the feebly attached portions of mordant and prevent the color from passing its proper limits. If, however, the first soaping has been insufficiently performed the dye spreads. This can to some extent be avoided by the objectionable process of putting soap into the dye bath. The patentees also put oily or fatty matters into the bath to prevent the spreading of the color. We have reason to believe that this patent process is not successful in practice.

Petroleum Oil.

Mr. George Wilson, of London, the eminent maker of stearic acid, has greatly improved the distillation of natural petroleums, by adding to the use of superheated steam, that of a vacuum, by means of an apparatus similar to the one used in sugar-making.—*Cosmos*, March, 1860.

A Substitute for Cochineal. Fuchsine.

MM. Renard and Frank by causing certain anhydrous metallic chlorides to re-act upon the alkaloids extracted from the products of coal, or derived from azotized hydro-carbons, have succeeded in producing in a regular and practical way, a new coloring matter which they call *Fuchsine*, of great body and of incomparable richness of color and lustre. It advantageously replaces cochineal, and will entirely dethrone *murexide*. Stuffs dyed with this color have already been introduced, and have been received with surprise and admiration.

Cosmos, March, 1860.

For the Journal of the Franklin Institute.

Particulars of the U. S. Steam Sloop Pocahontas.

Hull built by U. S. Government at Gosport Navy Yard. Machinery originally built by Harrison Loring, of Boston; rebuilt at the Gosport Navy Yard.

Hull.—			
Length from knighthead to taffrail,		171 feet.	
" on load water line,		154 "	
Breadth of beam, extreme,		30 "	4 inches.
Depth of hold,		13 "	6 "
Length of engine and boiler space,		30 "	
Draft of water,		12 "	
Displacement at load draft,	775 tons.		
Tonnage,	694 "		
Engines.—Two—Vertical direct action.			
Diameter of cylinder,			33 inches.
Length of stroke,		2 feet	6 "
Diameter of shaft,			8 "
Cut-off—fixed slide—half-stroke.			
Maximum pressure of steam,	20 lbs.		
" revolutions,	70.		
Boilers.—Two—Martin's vertical tubular.			
Length of boilers,		11 feet.	
Width "		9 "	3 inches.
Height " exclusive of steam chimney,		9 "	6 "
" " inclusive "		13 "	6 "
Furnaces in each boiler,	3.		
Breadth of furnace,		2 "	5 "
Length of grate bars,		6 "	
Number of tubes (iron),	1260.		
Length of tube,		2 "	3 "
External diameter,			2 "
Grate surface,	87 sq. ft.		
Heating surface,	2251 "		
Diameter of smoke pipe,		4 "	5 "
Height " above grates,		44 "	
Screw.—Uniform.			
Diameter,		10 feet.	
Length at hub,		2 "	
" periphery,		1 "	9 inches.
Pitch,		18 "	
Number of blades,	2.		

Remarks.—During a trial at sea, March 27, 1860, speed 8 knots. Revolutions, 59. Steam, 15 lbs.

J. H. W.

Effect of Pressure on Electro-conducting Power.

M. Elie Wartmann has found experimentally that the electric conductibility of copper wire is sensibly diminished by a pressure of 50 atmospheres, that this diminution increases with the pressure, and disappears when the pressure is relieved. The experiments were carried up to 400 atmospheres. These results establish a new analogy between heat, light, and electricity.—*L'Institut.*

Specification of the Patent granted to WILLIAM CLARK, *for Improvements in obtaining or extracting Quinine and the principal Organic Alkalies.*—Dated May 3, 1859.—(A Communication.)*

The several processes for the manufacture of sulphate of quinine which have been made use of or suggested to the present time are well known, and consist in the action either of alcohol, or of essences, schist oils, or of coal and other carburets of hydrogen on the raw precipitate, dried or pulverized, and producing decoction of quinquina. The several agents exhausting the precipitate more or less completely produce a sulphate of quinine of greater or less strength. The principal objections to the employment of these substances are their volatileness and the loss resulting from their use; the necessity for drying and pulverizing the precipitate, and consequently the danger and even certainty of leaving some quinine unextracted. In short, all the known processes, with the exception of the direct treatment of the bark by means of alcohol, present the grave objection of leaving a great quantity of the quinine in the mother water of the decoction, which will be precipitated at the bottom in a raw state, from which it has to be withdrawn by evaporation at comparatively great expense in relation to the result.

The improved method herein proposed, appears to be exempt from the above-mentioned defects, and also presents great advantages, which are as follows:—A decoction is obtained from the bark in the ordinary manner by means of hydrochloric or sulphuric acids; an alkali or alkaline carburet is then added, such as soda, ammonia, or carbonate of soda, until precipitation ceases; at this moment the liquor becomes entirely alkaline, care being taken that the excess of alkali be as little as possible. The liquor holding the precipitate in suspension is then boiled, and a certain quantity of solid fatty acids, such as stearic or margaric acids, added; these acids then melt and form a layer on the surface with which all parts of the liquid under the influence of ebullition come in contact successively; in this manner the quinine being dissolved in the water combines with the fatty acids, and forms with it a perfectly insoluble soap. After a certain time the precipitate becomes of a blackish color, and the alkaline liquor is transformed into quinic acid, neither one nor the other containing any trace of the quinine or cinchonine, which are entirely absorbed by the fatty acids. The liquor is then allowed to rest and cool. When the fatty acids become solidified on the surface, they are removed in the form of a cake, and then boiled with distilled water for the purpose of removing any impurities with which it may be mechanically combined. This is continued until the fatty matter yields nothing more to the pure water; it is then boiled in water acidulated with sulphuric acid, and the excess of acid subsequently saturated in the ordinary manner by means of an alkali; some dark matters will be precipitated, and after filtration a crystallized block of sulphate of quinine will be obtained by cooling, which block may be purified as in ordinary.

*From the Repertory of Patent Inventions, Feb., 1860.

It will be understood that the right is reserved of using any fatty acid, either solid or liquid, or oils which may be spontaneously acidified, or of all substances which may directly, or by a double decomposition, produce an insoluble combination of fatty acids and quinine or quinine soap. However, in practice, preference is given to fatty acids produced by the fusion of candles, which are unalterable in the atmosphere and do not mix with water, are easily separated from the precipitate, and also have the great advantage of becoming solid; the operation effected by these means is complete, very simple and rapid in execution. It will be understood that this improved process is also applicable for the extraction of alkalies from opium, morphia, codéia, &c. The operation as applied to opium is effected in a precisely similar manner as for the precipitation of quinine. It will be observed that the principal feature of the present invention is the use of fatty acids for the extraction of matters from any vegetable base, as hereinbefore described.

Specification of the Patent granted to Walter Crum, *for Improvements in Printing and Dyeing Textile Fibres and Fabrics.*—Dated May 23, 1859.*

My invention consists in a mode of treating gluten, and employing it in conjunction with an alkali as a mordant or intermedium for attracting and fixing certain coloring matters to cotton and other vegetable textile fibres and fabrics.

The method is to mix gluten with caustic potash or soda, or with the silicate of potash or soda; to print or otherwise impregnate the fibre or fabric with the solution or mixture so produced in the manner well known to calico printers and dyers; to subject the fibre or fabric so impregnated to the joint action of heat and moisture, and then to apply the particular coloring matter which is to be attracted and fixed.

The process I adopt is as follows:—

First, I take the gluten of wheat as it is produced in the well-known process of kneading the flour of wheat with water and washing away the starch, and I allow it to remain in a suitable vessel until it has lost its tenacious character and acquired in some measure that of a mucilage. The period at which this change takes place varies with the different qualities of flour from which the gluten is produced, and the temperature at which it is kept. It is usually sufficiently fluid after five or six days when kept at summer heat, and between that period and eight or ten days thereafter it is in the best condition to be used for the purposes of this invention.

Secondly, I then proceed to purify this mucilage by rendering the gluten which it contains again insoluble and coherent, and for that purpose I mix it with a solution of carbonate of soda sufficient to saturate the acid which has been formed in it; the point of saturation being indicated by test paper in the usual way. For ten pounds of gluten in this condition there is usually required eighteen ounces of solution

* From the Repertory of Patent Inventions, Feb. 1860.

of carbonate of soda of specific gravity 1·150. The gluten in becoming again insoluble gradually separates from the soda solution, and partially resumes its tenacious and coherent state, and the whole being shaken on a cloth, the solution passes away along with some portions of starch not previously separated. Assuming the above quantities to have been used, the gluten remaining is then to be kneaded or washed with three pounds of cold water and shaken on a cloth as before; and this washing operation is to be performed three times.

Thirdly, ten pounds by weight of the purified gluten is to be mixed with fourteen ounces of solution of caustic soda, specific gravity 1·080. The gluten immediately dissolves and forms a mucilage, which is to be diluted with water to the required thickness, as is understood by calico printers. For cylinder printing I usually add seven pounds of water.

Fourthly, when the fibre or fabric of cotton or linen has been printed or otherwise impregnated with the compound just described, and dried, it is subjected to the action of steam (or of heated air more or less moist), then rinsed in water; and,

Fifthly, dyed in a preparation of orchil in the manner well known, or in picric acid or dinitrophenylic acid, or in the coloring matter obtained from coal tar or from aniline; or the same coloring matters may be applied by printing them upon a fibre or fabric previously prepared with the glutinous mordant fixed by steam, and subsequently again subjecting the printed fabric to steam.

Although I adopt by preference for the purification of the gluten, as above described, the employment of carbonate of soda, yet I find that other substances, caustic soda, or potash or ammonia, or the carbonates of potash or ammonia, or the sulphates or phosphates of soda or potash, or common salt, or nitric acid, may be employed for reproducing the insoluble and coherent condition of the gluten; but I find the alkaline carbonates the most suitable substances. I also find that gluten may be employed without the prescribed purification, and at an earlier or later period after its separation from the starch, though not, as I believe, to the same advantage as the prepared gluten, nor with the same certainty of a uniform result. If taken at an early period, the gluten should be mixed with about a fourth of its weight of caustic soda, specific gravity 1·080, and if taken after the gluten has attained its most fluid condition, it should be mixed with about one-third of its weight of the same caustic soda, more soda being required in proportion to the length of time the gluten is kept, and in these several operations the soda may be replaced by an equivalent quantity of potash.

Having now described the nature of my invention, and the manner of performing the same, I would observe that I do not confine myself to the precise details referred to, as the same may be varied without deviating from the peculiar character of my invention; nor do I confine myself to the precise proportions given, as these may be varied with advantage, according to the condition of the gluten, which again varies with the quality of the flour from which the gluten is produced, with its own age and purity, and with the temperature at which it is kept. These are points which will readily be understood and allowed

for by any competent workman, who, when his material varies in character, has only to test it by a preliminary trial with proportions of alkali slightly varying, and to observe what proportion gives the best result on being dyed. The alkaline salts, silicate of soda or potash, in which the alkali has not entirely lost its alkaline character, and in proportions containing an equal quantity of alkali with that mentioned above, may be employed for dissolving the purified gluten, although, as I believe, with less advantage than the alkalies which I have named. And I do not claim the employment of a mixture of gluten, alkali, and coloring matter, unless such gluten shall have been purified in the manner hereinbefore described, or unless such mixture shall be used after its application to the fibre or fabric as a mordant for the coloring matters already specified.

But what I do claim is,—

The application of gluten along with potash or soda, or the silicate of potash or soda, to cotton and other vegetable textile fibres and fabrics as a mordant for attracting and fixing any of the coloring matters above stated, with which it is brought in contact after being applied to the fibre or fabric; and I also claim the treating and purifying of gluten in the manner and by the materials above described.

Translated for the Journal of the Franklin Institute.

The Screw Propeller.

A French engineer, M. Taurines, has been performing an interesting set of experiments on the effects of the screw propeller by means of a new instrument which he calls a *Helicometer;* which consists of two, and sometimes three dynamometers, each of which is composed of a series of comparatively feeble springs so that they will measure light or powerful effects with equal precision. Of the two dynamometers of the helicometers, one measures the force transmitted to the shaft of the propeller, and the other the pressure of the propeller; these two data joined to the velocity of the vessel give three of the four quantities which enter into the fundamental equation of the work done, so that the fourth may be determined. For, let P represent the force transmitted to the shaft, in kilogrammetres; the pressure in kilogrammes R, the velocity v and the co-efficient of useful effect p; we shall have the equation, $\text{P}\,p = \text{R}\,v$, or, $p = \frac{\text{R}\,v}{\text{P}}$; in which R, P, and v are given by the observations. This determination has the advantage of being independent of all hypothesis, and gives the true mechanical effect to the propeller.

The most valuable part of M. Taurines' work is the numerous applications which he has made of his helicometer to the measurement of useful effect of more than forty screws differing very much from each other in pitch, diameter, fraction of surface, and number of blades. He experimented at first on a large boat which he had built on purpose. The steam engine was of high pressure and cog-geared, the motor

wheel having 90 teeth; the pinion on the shaft did not gear directly into this wheel, but into an intermediate one, so that the pinion could be changed at will; the pinions varied by two teeth each, from 20 to 40 teeth; each stroke of the piston produced, as desired, from 2½ to 4½ turns of the screw. The machine preserving sensibly the same velocity. The 40 propellers, all of the common form, were of cast copper with planed surfaces and carefully verified.

The essential elements of a screw propeller are, *the pitch, the diameter, the number of blades, and the fraction of the surface*, and it was required to appreciate in turn the influence of each of these elements. In these experiments the pitch varied from 0·535 to 1·4 metres; the diameter from 0·475 to 0·640 metres; the number of blades from 2 to 6; the fraction of surface from 0·14 to 0·519.

We have not access to the five tables in which M. Taurines has given the numerical results of his experiments, in which he registered and calculated over 5000 metres (more than three miles of curves), but the following are the general conclusions:—

1. *Influence of the Pitch.*—The examination of the five groups of experiments shows that in every case, without exception, *the useful effect diminishes as the pitch increases.* Thus with screws of the same diameter and same number of blades, as the pitch increased from 0·535 to 1·4 metres, the useful effect fell from 0·66 to 0·45.

2. *Influence of the Diameter.*—The three sets of experiments on this subject show that a considerable advantage arises from the use of screws of large diameter; the useful effect is considerably increased, and the number of turns of the screw may be much reduced.

3. *Influence of the Number of Blades.*—The 4-bladed screw is always superior to the 2-bladed; but the advantage was not sufficient to overcome the other advantages of the latter.

4. *Influence of the Fraction of Surface.*—The fraction of surface may be considerably reduced without much altering the useful effect; screws having fractions 0·135 and 0·14 gave useful effects of 0·698 and 0·658. But if the fraction be too small the machine will not work so regularly; especially for screws of four or five blades the fraction of surface ought to have a certain value.

Besides these four influences M. Taurines studied the effect of the velocity of the vessel upon the resistance of the water. He tried three screws with velocities of from 1·5 to 2 metres; with the first two, the experiments were divided; that is, the movement was alternately fast and slow so as to preserve uniformity of condition. From the comparison of the numbers it is seen that the resistance increased more rapidly than the square of the velocity, and was proportional to the power whose index is 2·591.

Preparation of Chrome-Green.

When a mixture of 3 parts of boracic acid and 1 part of bi-chromate of potassa is calcined at a temperature of about 932°, there is a disengagement of water and oxygen, and a formation of a double

borate of potassa, and sesqui-oxide of chromium. This salt which is fixed at ordinary temperatures is decomposed by water into acid borate of potassa, and sesqui-oxide of chromium, which, in its nascent state, absorbs water, and forms a hydrate of a superb color. The hydrated oxide is separated from the acid salt by washing and decantation.

This method is devised by M. Guignet, of the Polytechnic School, and the resulting chrome-green is put into commerce, either as an oil paint, or as a color for printing calicoes. To make the first, it is dried and powdered; to form the second, the paste is introduced directly into the grinding mill. This color is of very great body, and of a brilliant tone, which it keeps in artificial light, and will form mixtures with the usual yellows, whose primitive purity remains unalterable.

Cosmos, December, 1859.

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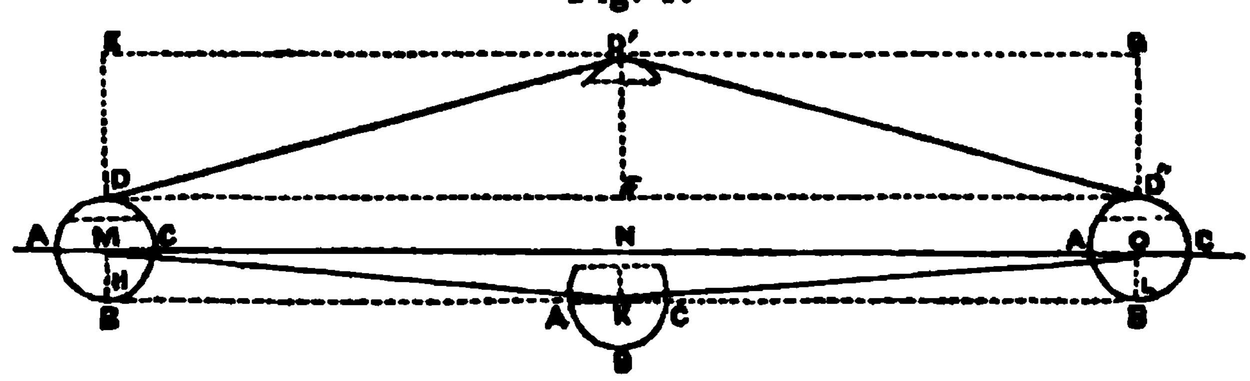
*On a System of Moving Bodies.** By ALEXANDER STEPHEN WILSON.

Theorem.—If in a system of bodies moving in a straight line in free space one part of the system be made a fulcrum for projecting another part, either in a plane perpendicular to the motion of the system, or parallel to that motion, such projection shall not alter the rate of motion of its centre of gravity, nor change that centre's line of motion; and the parts projected, when they have described the resultant of the forces by which they are moved, shall be again brought by the unvarying motion of the centre of gravity, as near as before projection, to the centre of the system.

Let A B C D (Fig. 1) be a system of bodies, moving in the line M N O. Complete the parallelograms E F and F G, and also H N and N L, and draw the diagonals D D′ and D′ D″, and likewise M K and K O. If from M the part D be projected in the line D E, the part A B C shall likewise be projected in the line M H; and the two projected parts shall first be carried beyond the line of motion M N O to D′ and K respectively, and next to O, or into the relation they occupied before projection.

Fig. 1.



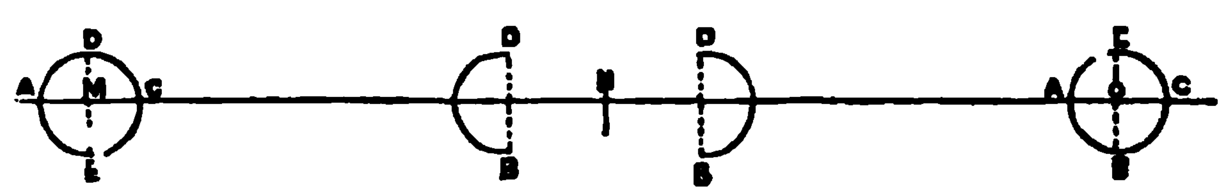


Fig. 2.

For if with the system at the point M the part D be projected in the line D E, perpendicular to the line of motion of the system, the remain-

* From the London Civ. Eng. and Arch. Jour., Dec., 1859.

ing part A B C shall by reaction be projected in the contrary direction, or in the line M H. But it is assumed that the system has a motion in space much more rapid than the motions of projection. And, by the principle of the parallelogram of forces, the resultant of D E and D F is D D′. And the resultant of M H and M N is M K. When, therefore, the system has moved to the point N, the part D will be at D′; and the part A B C at K. And because action and reaction are equal and contrary, the reciprocal projection of the two parts will leave the centre of gravity of the system unaffected in the point N, at a distance from either of the displaced parts determined by its relative momentum; while the ratio which the respective forces D E and M H bear to the force M N or D F, determines the limits of projection F D′ and N K. But it is involved in the second law of motion, that bodies must move in the line of the force by which they are moved. Now, the parts at D′ and K have been projected out of the line M N O, by which these parts are virtually moved, and to which they are as much connected at N as they were at M. For, since it is the momentum of the system which enables the projecting force to act, it is the motion of the system which impels the parts into the line of that motion. This force therefore at N, where the resultants of projection and translation in space terminate, must bring the displaced parts again down to the centre of gravity, or towards the line of the force by which they are moved. The motion of the system being the force which opposed the separation of the parts, is, necessarily, a force drawing the parts again together; or, more properly, drawing each of the parts into its own line of motion. But if the force represented by N O draws the projected parts into the line of that force, then because the part D′ is moving in the line D′ G, and the part A B C in the line K L, the parts are respectively acted on by forces moving parallel to D′ F and D′ G, and to K N and K L; and the lines into which these forces may be respectively resolved are D′ D″ and K O. Therefore, at the point O, the motion of the system has brought the projected parts again as near to the centre of that system as before projection.

Again, let A B C D (Fig. 2) be a system of bodies moving in the line M N O with a uniform rate of motion. Let the system be separable into two equal parts in the plane B D; and let a force of projection be introduced at M, acting parallel to the motion of the system. If the two parts be separated as at A B D and B C D when the system arrives at N, these two parts shall be again united by the motion of the system when the centre of gravity arrives at O.

For if the act of projection takes place at M, it is clear that in one part the force of projection will be added to the motion of the centre of gravity, and in the other subtracted from it; so that when that centre arrives at N, one part of the system will be at A B D and the other at B C D. The half of the system A B D will be made to move slower than the uniform rate of the centre; and because it was the reaction or resistance to increased motion of the other half, B C D used as a fulcrum, which enabled the force of projection to lessen the motion of A B D, the amount of motion subtracted from A B D must be precisely the amount

added to B C D; and therefore, by the equality of action and reaction, B C D will move as much faster than the centre of the system as A B D moves slower; and the centre will thus remain unaffected. But the two parts thus mechanically separated are still dynamically connected with the centre of motion as much as before separation. The position of the two parts at N are the total resultants of the force of projection, combined with the uniform motion of the centre. The force of projection, in respect of both parts, is opposed by a contrary force. A B D in coming from M is moving slower than the motive force of the system; but, being part of that system, the motive force is constantly acting against the retarding force of projection, and therefore constantly accelerating this part, until at A B D it momentarily possesses the same rate as the centre N. Conversely, the part B C D is, during the same time, moving faster than the centre of the system, which consequently necessitates its retardation, because the slower motion of the centre of the system is acting against the force of projection, until at B C D this part likewise passes through the point of equal motion with the centre N. But at N, the part A B D possesses the uniform rate of the system, *plus* the force of acceleration which brought it up to that rate; and the part B C D possesses the uniform rate of the system, *minus* the force of retardation which brought it back to that rate. Therefore, at N, the relative motions of the parts will become reversed,—A B D will now move faster than N and B C D slower, because A B D possesses the rate of the system, *plus* its acquired force of acceleration, therefore it must move faster than N; and because B C D possesses the rate of the system, *minus* its acquired force of retardation, therefore it must move slower than N. But because A B D, after passing its position at N, is moving faster than the centre of the system, and B C D slower, they must meet in the point O. And because the part A B D will then have just as much more motion than O, or than the centre of gravity, as B C D has less, the uniform rate of the centre of the system will still remain unaffected. For at every moment, the motions of the parts added together, the one being positive and the other negative, give the normal motion of the system. Therefore, the progressive motion of a system of bodies will cause the parts of the system separated in a line parallel to that motion again to meet.

Corollary.—It follows from these two cases, which are susceptible of an infinite variety of combinations—depending upon the angle which the plane of projection makes with the plane of motion—that since it is the motion of the system which brings the projected parts together, the force of projection displacing the parts is a force exerted, not to overcome any inherent attraction in the parts, but to change the direction of motion in these parts. Therefore, if the system were at perfect rest, there could be no projection, since there would be no motion to create a fulcrum. Also, the faster a system is moving, the greater will be the weight or momentum of its parts, since the weight is not an inherent quality of matter, nor a result of any inherent power in matter, but simply a result of motion. It likewise follows that, as the planets are systems of moving bodies, the motion of projectiles on their

surfaces, and the whole phenomena of weight—differing in value, as they must do, with the respective rates of each planet—are solely referable to the motions of these systems. From which it is easily deducible, that *the motion of the terrestrial system is terrestrial gravitation.*

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*On the Application of Superheated Steam in Marine Engines.** By the PRESIDENT of the Institution of Mechanical Engineers.

An opinion in favor of superheating the steam supplied to steam engines has long existed, and it has been maintained by many that important advantages might be obtained from this principle; though until recently but little has been effected in its practical application, and much doubt has been felt as to its advantages proving sufficient to lead to its general adoption. The development of the principle has probably been checked by exaggerated ideas being entertained respecting its advantages on the part of its earlier advocates; and also by somewhat incorrect views of the action of superheated steam, leading to attempts to carry the superheating to an excessive degree, thereby involving much extra risk of failure and stoppage of the apparatus, and tending to discourage further pursuit of the object.

Superheated steam seems to have been definitely tried about 27 years ago by Mr. Thomas Howard, of Rotherhithe; but in this case the boiler or vaporizer was dry, and only enough water was injected at each stroke of the engine to supply the necessary quantity of steam. It would appear from the experiments made, that very considerable economy was effected; but although the apparatus thoroughly established the principle, it was too delicate in its construction, and was for this reason given up. Mr. Howard appeared to be fully alive to all the advantages of the system, and always expressed his opinion that there was a loss of 30 per cent. in an ordinary steam engine, which would be recovered by superheating the steam. Soon afterwards the late Dr. Haycraft, of Greenwich, took up the subject and advocated it strongly, being convinced that great advantages would be obtained by superheating the steam in engines; and he used to express his confidence that the time would come when the principle would be generally adopted, and that a saving of 30 per cent. in the consumption of fuel would be thereby effected.

The importance of the principle was first impressed upon the writer many years ago by Mr. Howard, and afterwards by Dr. Haycraft, with both of whom he was very intimate; and he has become satisfied from the results of experiment and observation that important advantages in economy of fuel may be obtained from the system; the main question to be settled being whether it involves any serious practical objection from complication of apparatus, risk of derangement and failure, or difficulty in lubrication of the engine. The recent trials he has made on a large scale have led him to the conclusions:

That an advantage can be obtained from the use of superheated steam amounting to an economy of fuel of from 20 to 30 per cent. in marine engines;

* From the Lond. Artisan, March, 1860.

That a moderate extent of superheating enables all the important advantages of the plan to be obtained;

And that apparently nothing objectionable is then necessarily involved from extra wear and tear, risk of failure, complication of apparatus, or difficulty in lubrication.

The real source of advantage in employing superheated steam, appears to be in preventing the presence of any water in the cylinder of the engine, and insuring, that the cylinder shall never be occupied by anything but pure steam; making it a real steam engine, instead of one working with a mixture of water and steam. In all condensing engines the interior of the cylinder being open to the condenser during half the time of each revolution of the crank is in communication during that time with the low temperature of the condenser, or about 110°, when the vacuum is 13½ lbs. per inch below the atmosphere, or 27 ins. of mercury. There is consequently a rapid radiation of heat from the sides and end of the cylinder, cooling down the whole mass of metal. The steam admitted into the cylinder in the next stroke, at a temperature of 206° if at 20 lbs. per inch above the atmosphere, coming in contact with these cooled surfaces, heats them up again, being robbed thereby of a portion of its heats; and the consequence is the deposit of a quantity of water in the cylinder, from condensation of an amount of steam proportioned to the quantity of heat imparted to the metal of the cylinder. A portion of this water in the cylinder may be evaporated again into steam towards the end of the stroke, by carrying the expansion of the steam down to a sufficiently low pressure; but even then its effective value as steam in propelling the piston will have been lost during all the previous portion of the stroke. The engine must, in fact, be looked upon as only in degree better than Newcomen's atmospheric engine, in which the whole of the steam was condensed in the cylinder at each stroke; and the advantages of Watt's great invention of condensation in a separate vessel are not fully realized until this serious defect is removed. Now, if as much heat be added to the steam by superheating it before entering the cylinder as will supply the amount of which it is robbed by the cylinder, it will remain perfect dry steam throughout the stroke, and not a drop of water will be deposited. This the writer believes to be the mode in which the superheating of steam acts in producing a saving of steam and consequent economy of fuel by preventing the extensive waste of steam that ordinarily takes place; and this indicates the extent to which the superheating can be carried with any great advantage. The writer believes that an addition of 100° of heat to the temperatures of the steam insures the accomplishment of the desired object with steam at 20 lbs. per inch above the atmosphere, as used in marine engines; the steam is thus heated from 260° to a temperature of 360°, and is then only about as hot as the ordinary high pressure steam of 120 lbs. per inch, used in locomotive engines.

The plan of superheating the steam before entering the cylinder is a simple and eligible mode of obtaining the desired object, and appears also to be preferable to a steam jacket. For when the steam is supplied

to the jacket from the same boiler as the cylinder, the supply of heat to the metal will be slower than in using superheated steam, owing to the difference of temperature being less; and to carry out the object fully, requires the steam in the jacket to be superheated, and the cylinder covers to be also jacketed, since in the short stroke marine engines, where the diameter is nearly double the length of stroke, the area of the two covers or ends equals that of the sides. But even then the application of the heat by the steam jacket is outside the cylinder, and the heat is delayed in its action by having to pass through the thick metal; whereas by introduction of superheated steam into the interior of the cylinder, the object is accomplished in the most direct manner, by heating the surface with which the steam comes in contact, and even a momentary chill of the steam down to the condensing point is entirely prevented. By superheating the steam with the waste heat of the smoke box, not otherwise usefully available, all this effect is obtained without cost; but with the steam jacket the heat used has to be supplied from the boiler. An important practical advantage attending the use of superheated steam is obviously that all objectionable joints of steam jackets are avoided; and the cylinder being felted and lagged the same as the steam jacket, there will be no more loss of heat by radiation from the outside.

The mode of superheating the steam may be varied in many ways: a general principle to be aimed at being to make use of the waste heat for this purpose after leaving the boiler, so as to accomplish the superheating without any cost of fuel; and to place the apparatus where it will not be exposed to injury from too great heat. The superheating apparatus has generally been placed in the smoke box or up-take flue in marine boilers, and has consisted of faggots of tubes or coils of pipes for the purpose of obtaining the required extent of heating surface within a limited space.

The accompanying drawings show the arrangement used by the writer and employed in a recent extensive trial of the plan in the *Valetta* steamer of the Peninsular and Oriental Company, of 260 nominal horse power, running between Malta and Alexandria. In the smoke-box of each boiler are placed two horizontal faggots of tubes, forming the superheating apparatus, each consisting of 44 wrought iron tubes, 2 inches diameter inside, and 6 feet 3 inches long, placed in vertical rows with clear spaces between them horizontally for allowing ready access in cleaning the boiler; these spaces are left opposite each row of tubes in a tubular boiler, but in the present case the boiler is constructed with Mr. Lamb's vertical flues in place of tubes. The superheating tubes are fixed into three flat chambers, which are made of wrought iron welded at the corners, and closed each with a single flanch joint. The steam is supplied from the boiler to the centre chamber through a stop-valve and pipe, and is taken off from the end chambers by stop-valves communicating with the steam pipes leading to the engines. The steam is thus made to pass through the superheating pipes on its way to the cylinder, and becomes superheated by taking up a portion of the waste heat escaping from the boiler flues

before reaching the up-take flue leading to the chimney. The steam pipes have also the ordinary direct communication with the boiler through second stop-valves, so that the whole superheating apparatus or either half of it can readily be shut off and disconnected at any time if desired.

The vessel has made two trips from Malta to Alexandria and back, a total distance of 3276 miles, with the superheating apparatus; and then two of the same trips without the apparatus, but with no other alteration. The result was a saving of 20 per cent. in the consumption of fuel, although the men were not experienced in the management of the apparatus; and there appears every reason to believe that when the apparatus has been a little longer time in use, the saving will be still greater. The main object kept in view in the detail of construction of the apparatus was to insure a simple and durable plan that would not require any repairs for a long time; and for this purpose the superheating tubes were made a thorough mechanical fit, and free from strain of expansion tending to make them leaky. The wrought iron tubes are $\frac{3}{16}$ inch thick, and have thick ends welded on to them, as shown half full size; these are turned down to a square shoulder, and all correctly to the same gauge for length, and fitted tight into the holes of the tube plate, which is also planed on the face and accurately bored; the tubes are then pressed into their places all at once by the plates being drawn together with screws, and are made steam-tight by the fit alone; the ends of the tubes are then expanded as shown. The total area of superheating surface including the wrought iron boxes is 374 square feet in each of the two boilers, giving a proportion of $2\frac{3}{4}$ square feet of superheating surface per nominal horse power, the engines being of 260 nominal horse power, and the boilers having a heating surface of 19 square feet per nominal horse power; this proportion appears from the writer's trials to be sufficient for superheating the steam to the extent that is desirable. The apparatus has not leaked or failed in any way during the time it has been at work, and appears likely to prove very durable.

The heat employed for superheating the steam is taken entirely from the waste heat after leaving the boiler, which would otherwise have escaped by the chimney; and this abstraction of heat from the smoke-box, together with the screen of superheating tubes, shielding the smoke-box doors, has produced a marked effect in keeping the stoke-hole uniformly much cooler when the superheating apparatus was applied than without it. The temperature of the steam is constantly indicated by a thermometer, which is fixed in a small cup projecting into the interior of the copper steam pipe, and containing a little mercury at the bottom in which the bulb of the thermometer is immersed. The fluctuations of this thermometer indicate very delicately the variations in temperature of the steam; and the mercury in the thermometer is affected considerably by the changes in firing, falling when the fire-door is opened for fresh firing.

In this arrangement no additional space is required for the superheating apparatus, the whole being contained within the ordinary

smoke-box, without any alteration of the boiler or any interference without its construction; the only external addition being the stop-valves communicating with the apparatus. This apparatus can therefore be readily applied to ordinary marine boilers, without requiring any alteration beyond the extra connexion and stop-valves, and without interfering with any of the arrangements of the engines or boilers; and the important saving of 20 to 30 per cent. of the fuel can be thus effected, without incurring any risk of trouble or delay from the superheating apparatus. In case of any failure of the apparatus, it will be seen that it is only necessary to shut one set of stop-valves and open the other.

The writer would observe in conclusion, that there are various plans adopted by different engineers for superheating the steam, many of which have been applied by the inventors, and in many cases with considerable success. Amongst these may be named those of Mr. Wethered, Mr. Partridge, and Mr. Pilgrim, who have done much lately to establish the value of the system by practical application.

The CHAIRMAN observed that the trial of superheated steam had been determined upon in the case of the vessel described in the paper, after the completion of the boilers; and the time being very short for fitting up the apparatus, he had to devise a means of accomplishing it without interfering with the work already done, and had consequently adopted the plan shown as the simplest arrangement and the quickest for construction. The apparatus was simply a work of repetition in the parts, the superheating tubes being all exactly alike, and fitted by machine work; the great object in view was to insure against any risk of interfering with the efficiency of the vessel by failure or accident with the new apparatus, and to arrange the whole so that it could be readily disconnected and the work carried on exactly the same as before the application of the superheating apparatus.

He had not had an opportunity of trying any experiments with it himself, and did not consider the trial at present made a fully conclusive one as to results; but the vessel had been three months working since the apparatus was applied, part of the time without the apparatus for the purpose of comparison, and a pretty satisfactory proof of its success was that the engineers were very glad to get the apparatus in again; and there was found to be a reduction of 20 per cent. in the consumption of fuel when the apparatus was used. He had tried one approximate experiment with the apparatus before the vessel left this country, by graduating the opening of the injection cock of the condenser, and observing the extent of opening required for working with and without superheated steam; and he found that little more than two-thirds of the quantity of injection water was required when the steam was superheated, showing that a much smaller quantity of steam must have passed through the cylinders into the condenser, with a corresponding saving in consumption of fuel in the boilers.

A difficulty was anticipated at first in keeping the joints all permanently tight throughout the apparatus, but none whatever was experienced, and there had been no leak since it was put to work; the

tubes were all made a thorough mechanical fit in the tube plates so as to be perfectly steam-tight, and they were not exposed to any strains from expansion and contraction, as the end chambers were free to move with the tubes, and the whole was of one material. It was an important point in anything of the kind to have a thorough good job made at first, and several of the attempts at applying superheated steam had been unsuccessful from failure of the apparatus in mechanical points, causing objections to be felt to superheating that did not really apply to the principle itself, but only to defects in the mode of carrying it out.

The CHAIRMAN replied that the pressure was kept the same, as it would be regulated in both cases by the load on the safety valves, which was not altered; the effect of the superheating could therefore be only to increase the volume of the steam by the expansion due to the increase of temperature, so that a greater quantity of steam at the same pressure would be supplied to the engines from the evaporation of the same quantity of water in the boilers.

Mr. E. A. COWPER observed that the pressure did not vary with the temperature; and whatever superheating took place, the effect could be only an increase in the volume of the steam and in its temperature, as it would be impossible for any difference of pressure to exist in the superheating apparatus, except, indeed, a slight diminution of pressure that would arise from the resistance of the small tubes to the passage of the steam. The first effect of the superheating would be the evaporation of all the moisture in the steam, as steam always left the water in a boiler in a more or less wet or damp state, from the mixture of minute particles of water with it, even when there was no sensible priming; it would then become perfect or dry steam, but at first would not be raised at all in temperature; but when the superheating was carried beyond that point, the temperature of the steam would be raised by all the heat added, and its volume proportionately increased, causing an increase in the total quantity of steam supplied at the same pressure and from the same evaporation of water. Steam was expanded by increase of temperature at pretty nearly the same rate as air and other gases: and since air at 32° was doubled in volume by an increase of temperature of 480°, steam at 20 lbs. per inch or 260° would be doubled in volume by 708° increase of temperature ($480° + 260° - 32° = 708°$); and a rise of a hundred degrees from 260° to 360° would consequently increase its volume $\frac{1}{7}$th, causing an equal saving in consumption of fuel when the superheating was effected by using the waste heat of the smoke-box. As the specific heat of steam was only about $\frac{3}{4}$ths that of air, steam would require only $\frac{3}{4}$ths the quantity of heat to be supplied to it to produce the same rise of temperature; and partly for this reason steam was now used instead of air in caloric engines, since the same effect of expansion was thereby obtained with so much less supply of heat.

There was no doubt that in cylinders without steam jackets condensation of a portion of the steam took place at the beginning of the

stroke, and a partial re-evaporation at the end, on account of the metal of the cylinder being colder than the fresh high pressure steam entering from the boiler, but hotter than the expanded steam in the cylinder at the end of the stroke; since the whole metal of the cylinder could not change in temperature twice in each stroke (though the interior surface must do so), the temperature of the cylinder and piston must be an average of the temperature of the whole of the steam coming in contact with them. He had tried a direct experiment suggested to him by Mr. Appold, namely: fixing a glass gauge tube in communication with the interior of the cylinder, the outer end of the tube being closed; at the beginning of the stroke, the interior of the glass became quite dull with moisture, from condensation going on in the cylinder; but towards the end of the stroke, the moisture was entirely evaporated and the glass became clear, showing that there was perfectly dry steam in the cylinder by that time. The cylinder was, in fact, a partial condenser at the beginning of the stroke, and a boiler at the end of the stroke; and if it were not for this boiling off of the condensed water at the end of the stroke, the cylinder would soon get very nearly to the temperature of the steam.

In an expansion engine without a steam jacket he had found by a comparison of the actual indicator figures with the theoretical figures which ought to have been obtained if no condensation had taken place in the cylinder, that the loss of power when cutting off the steam

at $\frac{2}{7}$	stroke amounted to	a loss of	11·7	per cent.
" $\frac{1}{5}$	"	"	19·6	"
" $\frac{1}{9}$	"	"	27·2	"
" $\frac{1}{11}$	"	"	44·5	"

But when the cylinder had a steam jacket supplied with steam direct from the boiler, he found the actual indicator figure almost exactly corresponded with the theoretical figure, except that at the end of the stroke it was raised a little, about $\frac{1}{2}$ lb. in pressure above the theoretical line, in consequence of the superheating of the expanded steam from the higher temperature of the metal of the cylinder. With steam in the jacket of the same pressure as that in the boiler he did not think there could be any condensation in the cylinder; for all that was requisite to prevent this was to keep up the metal of the cylinder at the temperature of the entering steam, by supplying the heat abstracted by exposure to the cooler steam during expansion, and that lost by radiation, which was very small in a well lagged cylinder; the piston ought to have non-conducting surfaces or plates, and the cylinder ends should have steam jackets.

He was very glad the important subject of superheating steam had been so well taken up in the interesting paper that had been given by the President, and was confident that a still higher saving of fuel than the 20 per cent. mentioned in the paper would ultimately be effected by that means.

*On the Production of the Purple and Rose-red Murexide Colors in Cotton Printing.**—By Dr. VON KURRER.

Murexide may be used in stuff printing, either in a powdered or pasty state. It need neither be chemically pure nor crystallized, because in such conditions it is too high in price.

A. *Printing with the Color.*—In 72 pounds of boiling water, 24 pounds of crystallized nitrate of lead are dissolved; and when the solution has cooled to 144° F., 5 pounds of dry, powdered, or 15 pounds of pasty murexide are dissolved in the fluid, and afterwards 36 pounds of finely powdered gum; after which the whole is passed through a handkerchief or a fine sieve, and left to cool, in which state it may be employed either for hand or roller printing.

After printing, the stuffs are hung up in a damp place until the impressed part feels soft, when the purpuret of lead is fixed upon the fibres by means of gaseous ammonia. This is best effected by hanging the stuffs in a hermetically closed chamber, such as is used for the sulphuring of woolen and silken tissues, by means of sulphurous acid. In place of the sulphurous acid produced by the combustion of sulphur, in this case gaseous ammonia is evolved from caustic lime and muriate of ammonia.

B. *Passage of the Stuffs through the Sublimate Bath.*—The pieces of stuff treated with gaseous ammonia are now passed through a bath containing in 1500 pounds of water, 2 pounds 11 ounces of corrosive sublimate (bichloride of mercury), previously dissolved in water.

In this bath each 3 pieces, of $\frac{5}{4}$ wide and 60 Brabant ells long, united together, are passed backwards and forwards; then for each following 3 pieces, 3 ounces of sublimate dissolved in water, are added. It depends on the pattern whether a greater or less number of pieces can be passed through the heated bath.

Light patterns enable 30 pieces of stuff of the above dimensions to be treated in the same bath; whilst with heavy designs a fresh bath must be prepared after 20 pieces have been treated.

As soon as each three pieces have passed through the sublimate bath, they are hung in flowing water until the pieces are collected, when they are passed together through the acetate of soda bath in an ordinary dye trough.

C. *Acetate of Soda Bath.*—This consists of 3000 pounds of water, into which 1 pound of acetate of soda and 1 pound of muriate of ammonia have been stirred.

In this bath 10 pieces of stuff attached to one another are passed to and fro over the *harpel* for twenty minutes, then washed clean in running water, freed from water in the wringing apparatus, and dried cold.

In the same bath, furnished with 1 pound of acetate of soda, but with no muriate of ammonia, 10 pieces of stuff are again treated.

In this way prints of the most brilliant purple-red color are produced. For pale gradations, in order to produce patterns in these dif-

* From the Lond. Chemical News, No. 2.

ferent red shades, namely, dark red, middling, and pale rose-red, the normal color for the two latter gradations receives a proportional addition of pure gum-water.

Cotton stuffs printed with murexide colors may be soaped without injury at 144° F.; the color also perfectly resists chlorine in the machine without any alteration; on the other hand, it is destroyed by hot aqueous vapors, and it is therefore impossible to combine murexide with the ordinary steam colors, such as green, blue, yellow, &c.

In cotton stuffs dyed with a single murexide red color, the ground color may be destroyed in particular spots, partly by oxidizing and partly by deoxidizing agents, and thus illuminated prints of the most beautiful and various patterns may be obtained. Thus by printing with acid zinc salts, orange figures are produced.

Dark grey figures are obtained by printing with protosalts of tin. Murexide printed upon medium pale-blue grounds produced with indigo, furnishes a remarkably fine violet. Stuffs dyed yellow with yellow vegetable pigments, receive figures of a Turkey-red color when printed on with murexide.

Silken and woolen fabrics dyed of a uniform red with murexide, may be bitten with yellow by means of picric acid, when the latter is mixed with an acid capable of decolorizing murexide. In the same way other active substances may be used for printing various figures of different colors.

D. *Preparation of Murexide Plate-printing Red.*—For the plate-printing of cotton fabrics, murexide will also be advantageously employed, when to 1 quart of the above-described purple color are added 2 ounces of bichloride of mercury, and 2 ounces of acetate of soda, each dissolved in half a pint of water. The stuffs printed with this color are hung up for three to four days, and then watered in the same way as in ordinary plate-printing. Murexide, however, can only be printed with wooden blocks, because brass decomposes the bichloride of mercury, and changes the color; this is also the case in roller-printing.—*Polytechn. Centralblatt*, 1859, p. 337.

Medals in Alloys of Platinum and Iridium.

M. Pelouze presented to the Academy of Sciences at Paris, in the name of M. Jacobi, medals of different sizes struck in alloys of platinum and iridium, fused at the laboratory of the *Ecole Normale*, by the process of MM. Deville and Debray. The alloys contained respectively 20, 10, and 5 per cent. of iridium. According to the declaration of M. Jacobi, they were rolled cold and without annealing, with great ease, and presenting the characters of the most ductile metals. Under the press they take a polish equal to that of coins; and the alloys rich in iridium, showed a hardness rather greater than that of gold of 0·916. This hardness is proportioned to the quantity of iridium, as is also the resistance of the alloy to aqua-regia, which becomes almost perfect when the quantity of iridium reaches 20 per cent.

Among the specimens laid upon the table of the Academy were two

medals, one of 63 mm. (2·5 ins.) diameter, bearing the effigy of the Emperor Nicholas; the other 41 mm. (1·6 ins.) in diameter, with the head of the Emperor Alexander 1st. These medals were struck in a platinum ore from the mines of Nischny-Tagilsk belonging to Prince Demidoff, and brought by General de Rachette. The ore fused alone by the method of MM. Deville and Debray gave an alloy, according to the analysis of M. Deville, of Platinum 92·6, Iridium 7, Rhodium 0·4. It was worked very easily, and gave a relief of 5 mm. (0·2 inch), which is greater than has ever been attempted with pure platinum. Their relief was remarkably uniform.

Pauvert's Method of Making Steel.

In the crucible, fragments of any kind of iron are cemented by means of a thorough mixture (or concentrated solution) of oxide of iron or manganese; common charcoal, fat, or resin, and an alkaline or earthy matter, such as potassa, soda, lime, or alumina, either in the condition of an oxide or as a salt. The carbon, impregnated by the oxides or salts, is no longer attacked by the air, and combines with the iron; the metals of the alkalies or alkaline earths, under the higher temperature, and in contact with carbon or iron, purify the steel by absorbing in their nascent state the phosphorus and other foreign metalloids.

Cosmos, January, 1860.

*On the Comparative Value of certain Salts for rendering Fabrics non-inflammable: being the substance of a Paper read before the British Association at Aberdeen.** By F. VERSMAN, F. C. S., and ALPHONS OPPENHEIM, Ph. D., A. C. S.

Women have a right to complain that while men have expended an immense amount of ingenuity in protecting themselves from one element—witness the enormous number of patents for rendering fabrics mostly employed for male garments *waterproof*—they have done very little to protect women from the more dangerous and domestie element —fire. We are happy to see that something has been done to wipe away the reproach; and it ought to be known that it has been done at the command of Her Majesty, at whose request the Master of the Mint employed the authors of the above paper to make experiments, the use of the royal laundry being granted for the purpose. Here, and at other places, the authors tried every salt they could think of, and some salts which few persons would ever have dreamt of employing. Of the substances used, however, two only seemed to fulfill all the purposes required. These are sulphate of ammonia and tungstate of soda; but as both of these salts are soluble, the difficulty of *fixing* an anti-inflammable substance in a fabric has yet to be overcome. For laundry purposes only the tungstate of soda can be recommended, inasmuch as the sulphate of ammonia sometimes produces brown spots like iron-moulds, when the fabric is ironed. The tungstate, however, offers one difficulty, viz: the formation of a bitungstate of little solubility, which

* From the Lond. Chemical News, No. 2.

crystallizes from the solution. To obtain a constant solution, a small per centage of phosphate of soda must be added. "The best way of preparing a solution of minimum strength is as follows:—A concentrated solution of tungstate of soda is diluted with water to 28° Twaddle, and then mixed with 3 per cent. of phosphate of soda. This solution was found to keep and answer well, and has been introduced into Her Majesty's laundry." We think Her Majesty would be pleased if the authors were to inform her subjects exactly how this solution is used in her laundry; and we shall be happy to be the medium of the communication. Appended to the paper are tables, showing the smallest per centage of salts required in solution for rendering muslin non-inflammable, from which we learn that of crystallized tungstate of soda, 20 per cent., and of anhydrous, 16 per cent. are required; and of crystallized sulphate of ammonia 7 per cent., of anhydrous 6·2 are wanted.

New Telegraph Line.

We copy from the *Cosmos* the project of a new telegraph line to connect Europe and America; giving for the information of our readers the intermediate stations as we find them in the original, so that if any of them should wish to correspond with any one or more of them, he may prepare his dispatches.

"The line leaves Europe by the ordinary road to Siberia, crosses the Oural Mountains near Ickaterinbourg; passes from the Oural to the Sea of Okhotsk by Tobolsk, Narym, Yenisseisk, Iarbinskäia, Yakoutsk, Okhotsk; passes northward and reaches Behring's Straits by Tapuisköi, Alansk, Anadyrsköiost; crosses the straits by a submarine cable of about 100 kilometres (62 miles); traverses diagonally Russian America; then passing down the coast penetrates into New Britain, which it traverses for 700 kilometres (435 miles); enters the northern part of the United States, traverses Oregon, and reaches the civilized parts of the United States, (*which begin at Westport,*) under the protection of the forts Wala-wola, *Hell*, Laramie; from Westport, *the line follows the road from California to New York* by Jefferson, St. Louis, Columbus, Wasinghton, Baltimore, Philadelphia, and *finally* reaches New York, its point of destination. Three great branches are to be taken from Tobolsk in Siberia, to India by Turkestan; from Yakoutsk, also in Siberia, to China and Pekin; and from Astoria in the United States, to San Francisco. The trunk-line will have five wires, and so will the branches; two for messages from America to Europe; two for those from Europe to America, and one auxiliary, (*fil de secours*, which will probably be much wanted. ED. J. F. I.)

"The length of wire will be 32,000 kilometres (19,890 miles), and will require ten million kilogrammes (10,000 tons) of galvanized iron wire of 3 millimetres (0·118 inch) diameter; 350,000 preserved posts, and two cables, one of 100 and the other of 50 kilometres, (62 and 31 miles). The cost of establishment may be estimated at 30,-000,000 francs, ($6,000,000,) and the annual expenses 7,000,000, ($1,400,000.) M. Jousselin thinks that he does not exaggerate the annual receipts at 9,000,000 francs, ($1,800,000,) and he consequently

believes that the undertaking will be really lucrative. (Six per cent. on the first cost at this estimate.)

"*The only grave objection* to this gigantic project, or the only serious fear we have for it is the crossing of Russian America, a country desolated by the ice of an eternal winter, and inhabited sparsely by demi-savage tribes."—*Cosmos*, January, 1860.

To this we have to add one fear, and one regret. The regret that the projectors have not added another branch to run from Behring's Straits along the southern shore of the Arctic Ocean, and up Smith's Sound; by means of which, we might constantly receive news of our whalers and Arctic Expeditions—besides the advantages in the coming observation of the Transit of Venus—the fear, that somewhere else along the route may be found some small additional tract of a few square miles, where the winter is as nearly eternal as in Russian America, and where the tribes are nearly as savage without being as sparse.

When this line is finished, our "old country" immigrants, meditating thoughtfully on the names of the places through which it is said to run, may find the realization of the old proverb, that "the longest way round, is the shortest way home." ED. J. F. I.

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*An Improved Means of Giving Increased Strength to Paper.**
By Thomas Taylor.

The invention consists in soaking paper (either sized, unsized, or partially sized) in a concentrated solution of neutral chloride of zinc, either warmed, or at the ordinary temperature of the air. The solution must have the specific gravity of 2100, or thereabouts, when it will have the consistence of syrup. The paper to be treated must be immersed in, or floated on, the solution until it is fully saturated; it is then removed and washed with water. If it is desirable to retain a portion of the zinc in the paper, it is, after being partially washed, immersed in a weak solution of carbonated alkali, and then thoroughly washed in water. After this treatment it will be found that the paper is more or less changed, has contracted in volume, become more dense, less porous, and much stronger. When it is desired to produce a more complete change, the solution must be heated, and the temperature may be varied from 80° or 90° F. to 212°, according to the effect desired. The change is completed when the paper becomes swollen, and apparently dry, as well as opaque and flaccid. If sheets of paper saturated with the solution be pressed together and ironed, they will become permanently united. In some cases the patentee dissolves cotton fibre, starch, dextrine or gum in the solution of chloride of zinc, or he adds the chlorides of tin, calcium, or magnesium; but the paper is always submitted to a thorough washing with water.

Paper thus treated, assumes more or less the toughness, semi-transparency, and general appearance of parchment.

* From the Lond. Chemical News, No. 2.

Our readers will remember that Mr. Gaine produced the same effect on paper by immersing it for a few seconds in oil of vitriol diluted with half its volume of water. The change in both cases is no doubt essentially molecular. We should like to know whether the whole of the chloride of zinc is removed in the washing.

Copying-Paper.

Copying-paper into the body of which a certain proportion of protosulphate of iron (copperas) has been introduced either during the manufacture or afterwards, by passing it between rollers covered with felt impregnated with a solution of salt, is much more advantageous in use than the common paper. A letter written with common ink containing an infusion of nutgalls, or having the tanno-gallate of iron for its base, and covered with the above copying-paper gives, by means of the press, a perfect fac simile. If a little sugar or pyro-gallic acid is added to the ink, a good copy may be had by pressing lightly the copying-paper upon the latter without the use of the press: taking only the precaution to interpose between the hand and the sheet of copying-paper, another sheet of oiled paper over which the rubbing must be done.—*Cosmos*, January, 1860.

Steel.

By incorporating into melted steel from 2 to 5 per cent. of Tungsten, there is obtained a steel which is very dense, hard, and strong; admirably fitted for the manufacture of tools. The instruments made with this Tungsten steel are said to keep their temper four times as long as usual.—*Cosmos*, March, 1860.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.,

Professor of Civil Engineering in the Philadelphia High School.

MARCH.—The month of March, this year, was remarkably mild. The temperature was 3½ degrees above the average for the last nine years, and the daily changes less than usual. The quantity of rain that fell was only half the average, and five inches less than in March of last year. March commenced with rain, which fell in showers on seven days of the month.

On the 9th and 10th, snow fell in large flakes, which melted as they fell. This was probably the last snow of the season.

The coldest day of the month was the 10th, of which the average temperature was 30·8°. The lowest degree reached by the thermometer was 25° on the 14th.

The warmest day was the 31st; mean temperature, 58·8°. The temperature was also highest on the same day, reaching 73°.

There were but three days of the month entirely clear or free from clouds at the hours of observation, and three days on which the sky was entirely covered with clouds.

The mercury stood highest in the barometer on the 16th, reaching

30·224 inches. It fell lowest on the 23d, when it stood at 29·499 inches.

A Comparison of some of the Meteorological Phenomena of March, 1860, with those of March, 1859, and of the same month for nine years, at Philadelphia.

	March, 1860.	March, 1859.	Mar. 9 years.
Thermometer.—Highest,	73°	70°	75°
" Lowest,	25	20	4
" Daily oscillation,	18·30	16·90	15·20
" Mean daily range,	5·40	6·00	6·10
" Means at 7 A. M.,	38 15	41·77	35·72
" " 2 P. M.,	52·34	55·31	47·34
" " 9 P. M.,	43·71	47·27	40·62
" " for the month,	44·73	48·12	41·23
Barometer.—Highest,	30·224 in.	30·360	30·522
" Lowest,	29·499	29·215	29·158
" Mean daily range,	·133	·250	·191
" Means at 7 A. M.,	29·829	29·777	29·845
" " 2 P. M.,	29·757	29·735	29·789
" " 9 P. M.,	29·795	29·762	29 821
" " for the month,	29·794	29·758	29·818
Rain and melted snow,	1·323 in.	6·503	2·566
Prevailing winds,	N. 79° W. ·224	S. 67° W. ·234.	N. 77° W. ·310.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, April 19, 1860.

John C. Cresson, President, in the chair.
John Agnew, Vice-President. } Present.
Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Donations to the Library were received from the Royal Society and the Royal Astronomical Society, London; de la Société d'Encouragement pour l'Industrie Nationale, Paris; the K. K. Geologischen Reichsanstalt, the K. K. Geographischen Gesellschaft, and the Oesterreichischen Ingenieur-Vereins, Vienna, Austria; L. A. Huguet-Latour, Esq., Montreal, Ca.; Joseph Bennett, Esq., Brooklyn, N. Y.; the State Lunatic Asylum, Utica, N. Y.; the Young Men's Association, Buffalo, N. Y.; the Baltimore & Ohio Railroad Co., Baltimore, Md.; John Heisely, Esq., Harrisburgh, Pa.; Col. J. Ross Snowden, U. S. Mint, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of March.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (11) were proposed, and the candidates proposed at the last meeting (9) duly elected.

Abstract of Meteorological Observations for February, 1860; made in Philadelphia, Adams, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.								GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 ft. Prof. M. JACOBS, Obs.				
	Barom	Thermometer.			Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.	Barom	Thermom.		Rain and Snow.	Prevail'g winds.
Feb.	Mean.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.		
	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Direc.
1	30·121	10·7	23	28·7	·036	44		N W.	29·780	7·0	27·3	0·100	(var.)
2	30·313	9·2	14	3·2	·038	45		N W.	29·948	4·3	6·7		S W.
3	30·271	13·8	19	4·7	·055	53		N N W.	29·900	6·7	12·3		S W.
4	30·238	24·3	18	10·5	·093	56		N N W.	29·856	19·0	12·3		(var.)
5	30·195	29·7	21	5·3	·138	70		N N E.	29·780	24·7	7·0	} 0·385	(var.)
○ 6	29·887	45·8	17	16·2	·306	89	0·195	(var.)	29·286	37·0	10·7		(var.)
7	29·816	42·2	13	3·7	·146	44		N W.	29·448	34·3	2·3		N W.
8	29·865	34·3	11	7·8	·129	54		N.	29·482	27·7	6·7		(var.)
9	29·661	38·5	22	5·5	·146	44		S S W.	29·229	36·7	9·7		(var.)
10	29·880	23·3	19	15·2	·071	50		N W.	29·596	17·7	19·0		N W.
11	29·899	20·7	13	2·7	·076	56	0·052	S E.	29·438	22·3	5·3		(var.)
12	30·000	28·0	12	7·3	·106	58		N W.	29·673	29·0	3·7		N E.
☾ 13	29·886	38·0	21	10·0	·187	48		S W.	29·475	37·7	11·7		S.
14	29·903	41·2	12	8·5	·162	58		(var.)	29·434	45·7	8·7		(var.)
15	29·801	30·2	11	11·0	·155	89	0·943	E N E.	29·362	28·7	19·0	0·675	N E.
16	29·694	28·8	17	3·7	·113	57		(var.)	29·323	18·7	8·0		(var.)
17	29·881	17·5	12	11·3	·068	57		N W.	29·482	11·7	7·0		W.
18	29·372	24·8	21	7·3	·174	94	1·150	N E.	28·875	21·7	10·0	0·600	N N E.
19	29·678	23·0	10	4·5	·076	52		N W.	29·377	17·7	4·0		W N W
20	30·010	28·0	22	7·3	·125	65		S W.	29·641	14·0	11·0		S.
● 21	30·076	40·7	21	12·7	·210	68		S W.	29·736	31·7	17·7		S.
22	29·772	50·7	20	10·0	·417	97	0·337	S E.	29·242	44·3	12·7	0·615	S S W.
23	29·591	56·5	23	9·5	·380	52	0·010	S W.	29·183	50·7	6·3		W.
24	29·721	43·3	20	9·8	·218	58	0·037	(var.)	29·379	38·7	12·0		N W.
25			18		·102	40		N W.	29·623	29·7	9·0		W S W.
26	30·252	35·3	18		·096	35		S W.	29·862	30·3	6·7		S W.
27	30·262	44·2	25	8·8	·207	47		S S W.	29·855	41·0	10·7		S.
28			21					S W.	29·864	46·7	5·7		S.
☽ 29	30·108	50·3	21		·320	69		N E.	29·817	50·3	4·3	0·250	S.
Means	29·924	32·3	18	8·8	·154	59	2·724	N 62° W.	29·544	28·4	9·9	2·625	S 74½° W.

1860.	CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm Heyser, Jr., Obs.					SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.						
	Barom	Thermom.		Rain and Snow.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.
Feb.	Mean.	Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·619	11·7			W.	27·819	6·3	23·3	·040	52		(var.)
2	29·767	11·0	3·3		W.	27·873	12·0	7·0	·135	100		W.
3	29·715	11·7	8·0		W.	27·836	13·0	4·3	·066	78		S E.
4	29·682	23·3	11·7		W.	27·826	31·0	18·0	·186	67		S W.
5	29·588	27·0	4·3	} 0·200	W.	27·742	28·7	7·0	·167	100	0·057	S.
○ 6	29·108	38·7	11·7		W.	27·452	43·0	14·3	·317	96		(var.)
7	29·836	35·7	3·0		W.	27·578	31·0	12·0	·165	72		W.
8	29·317	29·7	6·0		W.	27·593	26·7	5·0	·110	49		N E.
9	29·065	38·3	9·3		W.	27·467	35·7	9·0	·201	62		W S W.
10	29·483	20·7	17·3		W.	27·754	13·0	22·7	·063	67		N W.
11	29·255	25·7	5·7		W.	27·466	22·3	9·3	·153	94	0·145	(var.)
12	29·474	25·7	3·3		W.	27·749	22·3	1·3	·140	78		(var.)
☾ 13	29·300	41·7	14·0	0·100	(var.)	27·607	42·3	20·0	·182	47	0·225	W S W.
14	29·349	44·0	11·7	} 1·600	W.	27·619	37·0	8·0	·168	65		(var.)
15	29·205	28·7	15·3		E.	27·390	29·7	7·3	·174	100	0·463	S E.
16	29·151	22·3	6·3		W.	27·406	20·3	9·3	·066	47		W.
17	29·308	20·0	2·3		E.	27·493	19·3	9·0	·153	88		(var.)
18	28·689	22·7	6·7	1·000	(var.)	26·985	25·7	6·3	·169	84	0·202	S.
19	29·213	20·7	4·7		W.	27·508	13·7	12·0	·085	72		W.
20	29·435	24·0	10·0		W.	27·689	33·0	19·3	·169	54		S W.
● 21	29·505	36·3	12·3		(var.)	27·730	44·0	11·0	·204	45		S E.
22	29·093	44·7	9·7	0·770	E.	27·369	54·7	10·7	·406	74	0·170	S.
23	29·040	47·3	6·7		W.	27·417	46·0	9·3	·219	54		W.
24	29·228	38·3	10·7		W.	27·538	32·3	13·3	·152	64		W.
25	29·465	31·0	7·3		W.	27·696	27·0	5·3	·161	89		W.
26	29·708	32·7	5·0		W.	27·906	31·7	7·0	·146	57		S W.
27	29·686	43·0	10·3		W.	27·907	46·7	15·3	·308	64		(var.)
28	29·684	46·7	3·7		W.	27·935	49·3	2·7	·302	62		S.
☽ 29	29·553	50·7	6·7		E.	27·791	50·3	2·3	·378	81	0·409	S.
Means	29·380	30·5	8·1	3·670	N 88° W.	27·625	30·7	10·4	·180	71	1·671	S 53° W.

Abstract of Meteorological Observations for February, 1860; made in Dauphin, Northumberland, Centre, Huntingdon, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Harrisburg, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. John Heisely, M.D., Obs.				Shamokin, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Frish, Obs.				Fleming, Centre Co. 40° 56′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs.			
Feb.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevailing winds.
	Inch.	°	°	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.
1	30·078	12·3	21·3	N W.	8·0	20·7	0·450	W.	7·3	17·7		N W.
2	30·288	10·7	1·7	(var.)	–1·0	9·0		W.	11·0	3·7		(var.)
3	30·211	13·3	2·7	S E.	6·0	8·7		(var.)	12·3	6·7		E.
4	30·142	22·0	8·7	N E.	18·7	13·7	0·350	W.	20·3	12·0		W.
5	30·085	27·0	6·0	N E.	25·0	11·0		(var.)	24·3	10·7	0·160	W.
○ 6	29·568	38·7	11·7	W.	45·3	20·3		W.	39·0	14·7		W.
7	29·712	39·3	1·7	N W.	33·3	12·0		W.	32·3	6·7		W.
8	29·753	33·3	6·0	N.	36·7	9·0		W.	25·7	8·0		W.
9	29·492	39·7	7·0	(var.)	36·3	9·7		(var.)	33·3	9·0	0·020	W.
10	29·866	24·7	15·0	N W.	20·0	17·3		W.	6·3	17·0		N W.
11	29·725	20·7	1·7	S.	19·0	8·7		W.	23·7	7·3	0·030	W.
12	29·917	28·7	3·0	N W.	26·3	7·7		W.	21·0	6·0		N W.
☾ 13	29·741	37·3	9·3	N E.	36·3	12·8		E.	37·0	20·0		N W.
14	29·763	41·7	9·0	N E.	33·7	15·3		S E.	37·0	17·3		(var.)
15	29·069	27·0	14·7	N E.	26·3	11·7	0·300	S E.	26·7	10·8	} 0·700	S E.
16	29·581	27·0	4·0	N W.	23·7	3·7		W.	23·0	4·8		N W.
17	29·739	20·0	7·0	W.	14·3	9·3		W.	9·0	14·0		N W.
18	29·153	21·3	4·7	N E.	20·3	7·3	0·485	(var.)	23·0	14·0	0·210	(var.)
19	29·606	23·8	4·7	N W.	29·3	2·0		W.	17·7	5·3		N W.
20	29·862	25·3	5·7	S W.	22·7	11·7		W.	20·0	13·3		W.
● 21	29·961	34·8	9·0	(var.)	37·8	14·7		W.	34·8	6·3		W.
22	29·640	44·7	10·3	E.	52·0	16·0	·500	E.	43·3	14·3	0·600	E.
23	29·436	50·3	5·0	W.	59·7	6·0		W.	44·0	6·7		N W.
24	29·640	39·3	10·3	N W.	37·3	16·3		W.	32·3	11·7		N W.
25	29·852	32·0	7·3	W.	30·0	7·8		W.	27·7	4·7		N W.
26	30·146	35·3	4·7	S W.	34·7	4·7		W.	31·0	4·7		(var.)
27	30·111	43·3	6·0	S.	42·7	10·7		W.	38·7	9·0		(var.)
28	30·109	47·0	4·3	S W.	46·7	9·0		W.	44·3	5·7		(var.)
☽ 29	30·008	60·0	3·0	E.	50·0	5·7		(var.)	50·3	6·0	0·500	E.
Means	29·818	31·5	7·2	N49°W.	29·2	10·3	2·085	S73°W.	29·1	9·9	2·410	N68°W.

1860.	Huntingdon, Huntingdon Co. 40°30′ N. 78°3′ W. Height, 734 ft. W. Brewster, M. D., Obs.					Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.			Tarentum, Allegheny Co. 40° 37′ N. 79° 46′ W. Height, 905 feet. J. H. Baird, Obs.		
Feb.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Prevail'g winds.	Thermometer. Mean.	Thermometer. Mean daily range.	Prevailing winds.
	Inch.	°	°	Inc		°	°	Direc.	°	°	Direc.
1	29·627	5·7	24·7			4·0	15·0	N.	7·0	16·7	(var.)
2	29·759	9·0	8·0			11·7	7·7	W S W.	16·3	9·3	(var.)
3	29·726	8·7	7·7			13·3	6·3	E S E.	17·7	8·0	S.
4	29·666	19·3	15·3			28·3	15·0	S E.	29·7	12·0	S.
5	29·586	26·3	12·3	0·1		35·7	10·0	S E.	36·0	6·3	E.
○ 6	29·132	39·0	12·7			40·7	7·0	(var.)	42·3	7·0	?
7	29·306	34·3	6·0			28·7	12·0	W.	31·0	11·3	(var.)
8	29·352	26·7	9·0			27·7	8·3	N E.	29·0	7·3	?
9	29·082	35·7	11·7			34·3	6·7	(var.)	36·0	7·0	S W.
10	29·511	18·0	19·0			10·7	23·7	N W.	14·7	21·3	N W.
11	29·254	24·7	6·7			25·3	12·7	S W.	25·3	10·7	(var.)
12	29·508	25·0	2·3			23·3	0·7	W.	24·0	2·0	(var.)
☾ 13	29·296	38·0	17·7			39·0	15·7	W S W.	38·7	15·0	?
14	29·325	40·3	15·0	} 1		35·0	10·0	(var.)	36·3	11·7	(var.)
15	29·220	28·5	12·0			28·7	6·3	S W.	32·7	6·7	E.
16	29·197	23·3	5·7			20·0	5·7	N W.	21·3	11·3	S W.
17	29·341	18·0	5·3			15·0	13·0	(var.)	13·0	9·7	?
18	28·744	25·7	8·3	0·4		26·0	16·3	(var.)	29·7	10·7	(var.)
19	29·273	16·3	9·3			12·7	16·0	S W.	15·3	14·3	S W.
20	29·406	24·0	17·0			30·3	17·7	S S W.	24·0	18·0	S W.
● 21	29·487	36·0	12·0			42·3	12·0	S E.	39·7	15·7	(var.)
22	29·063	49·0	13·0	0·4		54·3	18·0	(var.)	57·7	18·0	(var.)
23	29·058	45·3	6·3			43·3	18·0	S W.	46·0	11·3	S W.
24	29·249	34·3	12·3			29·0	12·7	N W.	30·0	16·0	(var.)
25	29·459	29·0	5·8			26·0	3·7	S W.	27·7	2·3	S W.
26	29·688	29·7	6·7			27·7	5·7	S W.	27·3	7·7	W.
27	29·646	40·7	11·0			47·0	13·7	S.	42·7	16·3	S W.
28	29·660	44·0	3·3			47·3	6·3	S.	46·0	4·7	S W.
☽ 29	29·624	62·3	8·3	1·4		54·3	6·7	S.	55·0	7·0	?
Means	29·388	29·2	10·5	2·110	North.	29·7	10·8	N. [illegible] W.	30·1	11·0	S67°W.

// JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

JUNE, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

On the Brooklyn Pumping Engine. By SAMUEL MCELROY, C. E.

This engine having been recently tested under its contract, and accepted on the part of the City of Brooklyn, a description of its dimensions and operation will be interesting to the profession.

It is constructed as the first of four eventually to be required in the engine-house now erected, which has an engine-room 84 ft. front by 77 ft. depth, with two boiler-room wings, 66½ ft. front by 45 ft. depth, furnishing ample accommodation to four engines with their appurtenances. The present contract for the works requires two engines.

The *Boilers* now built are three in number, of the drop-return flue variety, cylindrical in form, 8 ft. in diameter, and 30 ft. long. The upper flues are 18 ins. in diameter, the return flues 9 ins. The stop valves, safety valves, feed cocks, and flue dampers are complete for each boiler, so that either may be shut off at any time. They are fed by an independent engine, connected with the hot-well, the pump-well, and the force main by independent pipes, so as to use either for supply. Advantage is taken of the heat in the lower boiler return by a pipe coil, to increase the temperature of the feed-water. For evaporation measurements a tank is provided in connexion with the "donkey."

The *Chimney* is 100 ft. high, built with an annular flue column, 4 ft. in internal diameter.

The *Engine* is double-acting, with a cylinder of 10 ft. stroke and 90 ins. bore, working two lifting pumps of 36 ins. bore and same stroke. The entire piston travel provided for is 10 ft. 3½ ins. The cylinder rests upon the double bed-plate which supports the entire length of the engine, and is directly over the pump-well.

The *Pump-well* is a massive granite structure 37 ft. high, with an inside area of 60 by 10 ft.; the side walls varying from 6½ to 5 ft. thick, the base being a heavy flat-arch, 30 ins. deep, resting on a plank floor, over a solid water gravel bed. Its depth of water way is 7 ft. The cylinder base is above the water-level of the boilers, and it is enclosed as to the cylinder body in a steam jacket case, very carefully felted, and covered with black-walnut lagging. The piston is 18 ins. deep at the centre, and 8½ at the edge, the rods being 8½ ins. diameter for the cylinder and pumps. The steam-pipes and side pipes are 20 ins. diameter. The valves are balanced puppets, 14 and 14½, and 16 and 16½ ins. diameter, and are filled out on the stems so as to reduce the waste of steam.

The cylinder *Valve-gear* is similar to that of a steamboat engine, as to the rock-shaft, lifting toes, and adjustable cut-off, but is not worked by an eccentric. It differs from the Cornish valve-gear, as to the valve-handles, cams, and plug-rods, while it retains the principle of the cataract in an independent water cylinder worked by the force-main, in connexion with a sliding frame attached to the engine beam. The frame operates the valves of the water cylinder, which opens the steam and exhaust valves of the main cylinder, in a quiet and readily adjustable manner, which is a great improvement over the Cornish valve-gear.

The *Beam* is 30 ft. long between end centres, 86 ins. deep at main centre, with a web 5¾ ins. thick, and flanches 16 ins. wide. The main journals are 13 ins. diameter by 24 ins. bearing, resting on massive pillow blocks, which are sustained by heavy ornamental cast iron frames. Parallel motions are used for the piston and pump-rod guides at either end.

The *Air-pump* has 36 ins. bore and 60 ins. stroke. It is double-acting, the condenser shower plates being arranged accordingly. The condenser is one-third the size of the cylinder, and takes its injection from the pump-well, or from the force-tube.

The *Pumps* connect with each end of the beam, the lower being placed under the cylinder, and on the floor of the well, and the upper in a chamber of masonry, which also supports the air-chamber. The pump buckets have double beat covers playing on the rods, with wood seats, alternately closing and opening as they work their water charge through each other, and move alternately towards and from each other, having a common connecting pipe of 3 ft. diameter. This feature is one of the leading peculiarities of this engine. Either the lower or upper bucket is constantly sustaining the water column, and keeping up its motion in the same direction, avoiding all losses of momentum and the abrupt change of centres, peculiar to other pumps. To obviate an objection which suggested itself to us at the outset, by the

friction *through* the bucket valves, in sucking by the upper pump or lifting by the lower, annular barrels are placed around each working barrel, 54 ins. in diameter, also provided with double beat covers, giving this additional area of supply and discharge. The small per centage of pumping friction in the engine is, to a great extent, attributable to this arrangement.

The *Air Chamber* connected with the upper pump delivery, is of cast iron, 6·5 ft. in diameter and 25 ft. high. An auxiliary pump is used for its supply, attached to the air pump-rod. A diaphragm plate is fitted in this chamber with valves which can be arranged to throttle the return pressure of the air, and with which some interesting experiments have been made, which demonstrate very forcibly the value of large air chambers in preference to stand-pipes or any similar appurtenances.

The *Force Tube* connecting the engine with the reservoir, is of cast iron, 3 ft. in diameter, and 3450 ft. long, with but one curve of 800 ft. radius. It has an overfall discharge into the influx chamber. One check-valve is used on it, about midway in its length.

Two *Counterweight Chests* are used: one attached to the upper pump-rod, below the outer end centre, and the other to the lower pump-rod, below the cylinder. A vibrating counterweight is also attached to the lower chest, with a countershaft, of such a form as to load the steam piston during half of its stroke, and lighten it the other half. These weights are of great importance to the smooth and economical working of the engine. Their total amount is 46 tons.

In the ornamental patterns of the castings, the finish of the bright work, the balcony frame, and other parts, and in all the details of construction, the builders have spared no pains or expense to make an engine of great durability and imposing appearance. Placed in a large room of first-class finish, closely connected with, and yet carefully separated from the boiler room and coal shed, the whole arrangement is successfully adapted to convenient and efficient work.

From January 12th to 14th, the trials were made under which the engine was accepted from the principal and sub-contractors by the City. The contracts require that for the test of *duty*, the engine should be capable of lifting 600,000 foot-pounds of water with one pound of coal, allowance being made to the engine for the friction of the pumps and force tube, during a trial of not less than 24 hours, with a delivery of not less than 10,000,000 gallons (N. Y.) into the reservoir. For the test of *capacity* the engine should lift not less than 10,000,000 gallons (N. Y.) into the reservoir in 16 hours. The duty test was made during 26 hours 3 minutes run, and subsequently the capacity test during 16 hours run, after the engine was "hooked on" at full speed. From the following synopsis of the notes it will be observed that the duty trial nearly equaled the capacity requirement of the contract.

Engine Trial of January 12th to 14th, 1860.

duty test.

Jan. 12. 10 35′ A.M. Engine stopped. Fires hauled. Counter 560,647.
" 10 40′ " Steam blown off. Furnaces wooded with 1180 lbs.
" 10 45′ " Started fires.

Jan. 12. 11 6′ A. M. Started engine. Steam 15 lbs.
Jan. 13. 1 9′ P. M. Engine stopped. Counter 575,612.
Hauled fires. Estimated value of grate contents at 856 pounds coal.

Running Time, 26h 3′ = 1563′.
Double Strokes, 14,965; average 9·57 per min.
Quantity Pumped, 2,000,000 cub. ft. measured in reservoir.
Actual Water Lift, 160 ft.
Equivalent " 170 ft. (includes pumping friction.)
Fuel Account, 1180 lbs. wood = 524 lbs. coal. Total fuel, 34,773 lbs.
Duty, 2,000,000 cub. ft. × 62·5 lbs. × 170′ lift ÷ 34,773 lbs. = 611·114 pounds raised one foot with one pound of coal.
Delivery of Pumps, 14,418,641 galls. (N. Y.) per 24 hours.
Engine Friction, 7·4 per cent. between cylinder and pumps.
Loss of Action, 1·69 per cent. in pumps.

CAPACITY TEST.

Jan. 13. 7 P. M. Commencement of test.
" 14. 11 A. M. End "
Running Time, 16 hours = 960 minutes.
Double Strokes, 9708; average 10·11 per minute.
Quantity Pumped, 1,325,800 cub. ft. in reservoir.
10,357,812 galls. per 16 hours.
15,536,718 " 24 "

The notes taken for the test of duty were made in the manner described at length in the paper on this subject in the April number of the *Journal of the Franklin Institute* for 1858, and furnish in my opinion the only safe and satisfactory means, in large experiments, of determining the actual quantity of coal used in producing a known result. The engine is taken at work, with the boilers and other parts in their ordinary working condition; it is then stopped, steam is blown off, new fires are lit, all the fuel used is charged to the experiment, and at its end credit is given for the fuel which remains among the contents of the grates and ash-pits, after the fires are hauled and cooled down. It is only in this item of credit that any range whatever is left to the judgment of experts, and a very simple process limits this range to a small chance of error. In the present case the fuel account is thus recorded:

Pine wood, 1180 lbs. =		524 lbs. coal.	
Total coal charged,		35,105	
			35,629 lbs.
Grate contents after hauling:—			
Ashes,	347 lbs.		
Refuse,	856 "		
Clinker,	375 "		
		1578 lbs.	
Coal,			856 lbs.
Total fuel used,			34,773 lbs.

Notes taken in repeated experiments of this kind, make it a very simple matter to show the impropriety of the usual method of taking the boiler fires in a certain condition, and *trying* to leave them in the same condition, but want of space will not permit it here.

The quantity pumped in all the experiments made with this engine, and in others tested for our information, has been carefully measured in the reservoir, and with gauges of a suitable kind this can be done

very readily and very accurately, even in a water basin of the large surface of the Ridgewood Western Division of about 551,000 sq. ft. The results on the duty trial were as follows:—

Measurement of water prism, . .	1,943,810 cub. ft.
" leakage at gates, . .	54,262 "
Estimate of absorption, . . .	1,928 "
Total, .	2,000,000 cub. ft.

The actual delivery of the pumps per double stroke was 1044·1 gallons. During the duty test, the average travel was determined from repeated observations at 9·875 ft., for which the theoretical discharge is 1062 gallons. The pumps, therefore, worked within 1·69 per cent. of their actual capacity, which shows a remarkably small loss of action. We have found it 6·56, 8, 14·5, and 16·3 per cent. in other engines, and in some cases it has ranged to 30 per cent. The "Leeghwater" engine, which ranks next in power, loses 10 per cent.

The actual water lift from the average level of the pump-well to the force tube discharge was 160 feet. The equivalent lift, as determined by the pump-cards, was 170 feet, showing the pumping friction of the pump and force tube to be 6·25 per cent. In trials of other engines, we find one pumping 3,287,860 gallons per day, with 7·25 per cent. friction; one pumping 1,771,396 gallons, with 17 per cent.; and another pumping 915,510 gallons per day, with 15 per cent. pumping friction; and these cases might be largely multiplied to compare with this engine delivering 14,418,641 gallons in the same time.

Comparing the average cylinder pressure, by the indicator cards taken during the duty test, with the pump-cards, the average pressure on 6375 sq. ins. being 12 lbs., and on 959·31 sq. ins. 73·91 lbs., the actual friction of the engine between the steam and pump pistons is 7·4 per cent. of the steam pressure. This result is remarkable, even when compared with first-class Cornish engines, and is entirely unapproachable by any crank movement in use.

The largest pumping engine in the world is the "Leeghwater" in the Harlaem Meer, and until the completion of the Brooklyn engine it was the most powerful. It has an annular cylinder of 12 and 7 ft. diameter, working 11 pumps of 63 ins. diameter, with 10 ft. stroke; the water lift being 13 ft. Its working speed varies from 5 to 7 strokes per minute, and its capacity of discharge per stroke is 2097 cub. ft. Its duty in foot-pounds per minute at 7 strokes is 11,926,642. The Brooklyn engine at 10 strokes per minute, with the actual discharge of its capacity test, performs a duty of 14,512,900 ft. lbs., and is then 21·6 per cent. more powerful. At 9·5 strokes per minute it has 15·6 per cent. excess of ordinary working power over its larger rival.

In connexion with its superior advantages as to *loss of action* in the pumps, light *pumping friction*, light *engine friction*, and *unequaled power*, the *smoothness of action* with which its work is done is remarkable. Perhaps the best indication of this quality is given in the readings of the pressure-gauge attached to the upper pump-head, which

have ranged for days from 55 to 58 and 59 lbs. pressure. There is no concussion in the valves, although so enormously large, and working at so great a speed under their head, and the quietness with which the cylinder valve motion performs its work, leaves nothing to be desired there as an improvement. In all the qualities named, this engine has fully realized our most sanguine expectations.

This engine was brought to my notice by Mr. Wm. Wright, Superintendent of the "Woodruff and Beach Iron Works," of Hartford, at a time when it was pre-determined by the Board of Water Commissioners, that the Cornish engines adopted by me for the original contract of the Brooklyn works should not be built, and it was necessary to secure if possible the next best style of engine. My observation and study had given me a strong favoritism for the single-acting engine, and in examining the various patterns of engines proposed for our works, the leading principles of that engine were taken as the basis of analysis. These may properly be reduced to two points, viz: the direct and simple character of the motion of the engine, with its durability and lightness of friction; and the use of a large mass of metal in motion, admitting high initial steam pressure and a high rate of expansion. There are minor advantages of the Cornish system, as to steam jackets, careful felting and covering, economy of steam in the passages, &c., which may be generally applied to any other style.

Although the plan of Mr. Wright was in a crude state, it was evident on inspection, that it contained the germ of a valuable engine, with all the leading peculiarities of the Cornish engine, obviating some of its disadvantages, and having obtained Woodruff and Beach's consent to alter the pump-valves from "butterfly" to "double beat," to put counterweight chests on the beam, to increase the size of the air-chamber, and to modify points of less consequence, I advised the adoption of the plan in April, 1857. Two other plans were, however, adopted successively; but in February, 1858, the engine then under construction, which was a fly-wheel engine, working its pumps by spiral cams, was abandoned for that now built.

The question which then presented itself to my mind, and which continued to present itself before the final completion of the engine, was its possible advantage over the Cornish engine, and my recommendation was not made without a careful study of engines in use, and the principles of motion involved.

The Cornish engine is single-acting, and with the exception of the suction lift of its plunger no pumping is done by the steam piston, its main force being expended in raising the counterweighted plunger. In one important sense, therefore, the cylinder is independent of the action of the pumping main.

It follows, then, in a case like that of the supply in question, where the capacity of the engine for a certain amount of work in a fixed time is determined, that the working operation of a Cornish cylinder being limited to one direction, and the speed of the descending plunger being limited by the conditions of water-flow through the valves and force tube, there is an important distinction as to capacity for work between

a single and double-acting engine of the same cylinder. The former pumps in but one direction, and the important water-stroke is not controlled in speed by the cylinder. In order to pump the same quantity of water in a given time, the Cornish engine must be more than twice the size of a double-acting engine.

It is also clear that for the same rate of delivery the Cornish plunger must be more than twice the capacity of a double-acting pump, and that the friction and disturbances of the pump are consequently magnified. This involves an advantage to double-action, in which the pump area need not exceed that of the force tube.

Up to the present time, however, although there are individual cases of double-acting engines more economical and efficient in work than individual cases of the single-acting, the latter as a general rule are entirely in advance of the former in these qualities and in that of durability. And the Cornish engines have the advantage in the friction of their working parts, due to their superior size and simplicity of motion, in their capacity for high initial steam pressure and rate of expansion, and in the superior manner in which they are jacketted, felted, and protected as to the cylinders, boilers, and other appurtenances from losses by radiation, condensation, and otherwise. The testimony of the records of pumping machinery to the date of the trial of the Brooklyn engine is conclusive as to the advantages in practical results of single-acting engines; and if it can be shown that this engine combines within itself all the advantages of the old system with its improvements in capacity for work, we have the whole Cornish testimony endorsing the principles of its success.

It was clear that there were advantages in compactness of arrangement and capacity in Mr. Wright's plan over the single-acting engine. For our work a Cornish engine of not less than 90 inches bore and 15 feet stroke, with a plunger of 50 inches diameter, was required to furnish the supply; and the leading machine shops of the country regarded this as an unwieldy and almost impracticable construction. While there is an advantage in large cylinders for economy over small cylinders, there is at present a practical limit to construction, which must be taken into account in putting work under contract, although the size named is not without precedent in marine engines, and there is also an additional responsibility in daily management. I do not, however, regard the erection and running of such an engine as impracticable, nor have I any doubt as to its economical results; but it is evident that the same results with a smaller engine are much to be preferred.

Conceding then to this plan, the merit of double-action and the disuse of cranks, fly wheels, and other power absorbents of double-acting engines, the question to be determined was, whether the leading features of the Cornish engine could not be embraced in this; or in other words, whether the steam could not be made to lift water instead of cast iron, and with the same economical results.

Starting on the assumption that this was the chief point at issue in this plan, a very careful study was made of the various pumping

engines within observation or placed on record as to those cases where the water was pumped directly by the steam; and the testimony on this point accumulated to many more examples than were at first anticipated. All the mining engines have one water lift at least by steam, and their economy is claimed to be enhanced accordingly; many cases of mining and pumping double-lifting engines occur in Europe and America; the great "Leeghwater" and "Cruquius" engines of the Harlaem Meer lift on their expanded steam, and the climacteric of pumping engines on record, in the Huelgoat Mines, with its vertical lift of 754 feet, belongs to the same class. Two things were clear in practice as in theory: that water could be lifted in this way, and that it could be lifted without injurious disturbance and with great economy. And the conclusion was finally expressed without hesitation, that the steam could be used for the direct water lift without any fear of its disturbing or controlling action on the expansion of the cylinder or the motion of the steam piston. I consider this the vital principle of the Brooklyn engine.

This point determined, the application of a second principle was very simple, and that is the inertia to be given to the working parts to insure a capacity for high initial steam, expansion, and steadiness of action. These points in an engine are determined by the item of *weight in motion*, much more positively than engineers as a general rule are willing to admit, and the success of the Cornish engine is involved herein. This proposition needs no elaborate argument; it is abundantly demonstrated in practice and easily proved in theory. Our own engine has settled this question beyond any controversy, and now lacks some ten tons of the working weight which was estimated for it before construction, and by consequence works with too low a steam gauge and too moderate a cut-off. The experimental weights added from time to time invariably increased the duty and are yet much below the proper standard.

As to the comparative principles of this engine and the Cornish, we claim to have demonstrated that the water can be readily pumped by direct steam lift without any disturbance to the cylinder, and that there is no difficulty in giving the beam and other working parts the same advantages of inertia. These are very important results. The relative capacity, cost, and management are also of great consequence in the comparison.

In connexion with the principle mentioned, that there were no injurious effects to be anticipated from the direct water lift by steam, there are to be considered the peculiar arrangement of the pumps, the areas of delivery, and the size and action of the air chamber, all of which tend to equalize and facilitate the flow.

The pump arrangement, by which each alternately works through the other, has been already described. The Cornish single-acting plungers and double-acting barrels, which put the suction column in motion in one direction, are obliged to reverse it on the return stroke, and thus lose the benefit of its momentum, finding this in fact a force to be overcome. In a number of pump cards taken from various en-

gines, I have found the difference in load between the commencement and end of this suction stroke occasionally to range up to 6 pounds per square inch on the piston. So sensible have hydraulic engineers been of this fact, that numerous ingenious devices have been made to secure a uniformity of motion in the same direction, and the principle is applied on a large scale in the Hartford Water Works engine, and controlled Mr. Wright's arrangement of this plan. There can be no question of its usefulness in retaining every expenditure of power, in preventing any serious loss of action in the pumps and in assisting the quiet opening and closing of the valves.

The facility of delivery through the inner and annular barrels, with their 36 and 54 inch double-beat valves has an important effect on the pumping friction, which as we have shown for the enormous delivery of 14½ millions of gallons per day increases the equivalent lift for both pumps and force tube but 10 feet in 160 or 6¼ per cent.; a case without any precedent in pumping experience. The annular barrels were not included in the contract plan, but were adopted at Mr. Wright's suggestion during construction.

Our experiments have also demonstrated the propriety at the outset of making the capacious air-chamber attached to the outboard pump. Various devices are in use for maintaining a continuous motion in force tubes when the plungers are not forcing or the pump pistons are on their centres. The rude and expensive English stand-pipe, which combines an entirely different use in furnishing a fixed head and a small reservoir and whose purpose seems to be much misapplied in our country, has this effect: in some cases, as a device much more rude, a secondary weighted plunger is applied to the tube for this purpose, but no appurtenances of the kind will compare in economy of cost and in softness of reaction with a properly proportioned air-chamber. A proper account of the experiments made on our air-chamber by means of a diaphragm plate fitted across its upper section and provided with adjustible throttle valves, would require much more space than can be taken here. They have all tended to show very clearly the importance of the air chamber to the action of the engine. The effect of the diaphragm when in use was to retard the speed of the engine and to improve the action of the valves, but the oscillation of the pumping column was much increased, affecting the force tube for a long distance and increasing the pump and cylinder load by an important per centage.

It is not claimed for this engine that the result in *duty* equals the highest standard of the best pumping engines, although in advance of any Cornish engine in this country; much better duty than 611,000 foot-pounds is reported in Europe, but in no European or American case are the engines worked with as low boiler pressure and expansion. We have demonstrated by experiments that our only hindrance to these conditions of great economy simply depends on additional weight in mötion, while at the same time it is demonstrated that an engine of this class is unprecedented in the items of working friction and smoothness of action. There can be no difficulty, therefore, in fitting the present engine or in building another so as to equal any

result ever actually attained in the venerable history of pumping machinery, and by conditions of experiment rigidly applied to this engine which admit of no contingencies or doubts.

This description of the engine, of its actual results, and of its principles of action, comprises in a general manner all that is requisite to its comprehension. It has been designated an experiment, and there may be a sense in which this is true, as no engine of the same peculiar combination was ever before built; but in those leading features, which clearly follow the well tried paths of known results or natural laws, it is in no sense experimental, and those who assumed the weighty responsibility of its success were fully justified in their undertaking. The engineer who studies carefully the lessons of past experience and the axioms of mechanical laws, will not be disappointed in the results of his combinations; and a demonstration like this, on so important a scale, of hydrodynamic laws, ought to be regarded with interest by the civil engineering profession. By the terms of their contract, Messrs. Woodruff and Beach, in case the engine had failed to perform its specified duty, were bound at their own cost to supply its place by another which would, and there are very few engine builders in this country who would have been willing to assume such a burthen. No small measure of praise is therefore due to them, and their very ingenious superintendent, for the confidence and ability with which their work was undertaken and completed.

Brooklyn, April, 1860.

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*Locomotives on Common Roads.**

The plan has been again revived of introducing steam locomotive carriages on common roads, and a committee of the House of Commons during the last session examined witnesses with a view to ascertain its practicability. The experiment of road locomotives had not a fair trial when formerly made, for the formation of railways, and the obstacles that were presented to the running of such carriages, for the time threw the project into the shade, and after several ingenious engineers had been ruined in the endeavor to construct locomotives adapted to the peculiarities of irregular surface traction, the notion was abandoned. The trustees of turnpike roads also, having tried to render the locomotives inoperative by covering the roads with quantities of loose stones, at length adopted the more effectual plan of getting the tolls on such carriages raised to a prohibitive rate. One of the chief objects of the select committee on the Locomotive Bill, which was brought into Parliament late in the session, was to ascertain whether the objections to steam carriages or wagons arising from the injury to the roads, and from the frightening of horses, had been overcome by Boydell's traction engine; and whether that method of traveling might not be revived by the application of his invention. The committee appointed to consider the bill met on the 19th of July, Mr. Garnett being appointed chairman. They sat only for three days, and examined the following witnesses: Mr. William M'Adam, Mr.

* From the Lond. Civ. Eng. and Arch. Journal, Sept., 1859.

Gibson, Mr. Henry Browse, and Mr. Frederick Hemming, when the preamble of the bill was agreed to, several amendments were made, and it was reported to the House.

The evidence given by Mr. M'Adam, the general surveyor of turnpike roads, was highly favorable to the traction engine, and he communicated the notes he made during an experimental journey with it from Thetford to London in May last. The importance of the subject will justify our quoting amply from his evidence, omitting those portions that had no immediate bearing on the question, and omitting also the questions of the members. Mr. M'Adam said:

"Up to the year 1857, I was perfectly convinced that locomotives could never travel upon turnpike roads, but I was then induced to see how they were constructed with what is called an endless railway; my curiosity then led me to look at it, and when I saw it I was so satisfied with the mechanical construction of it, that I saw the company, and requested that they would give me an opportunity of traveling with an engine, so that I might see the effect of it, both as to draft and as to its effect upon the road. They allowed me to do so, and I went to Thetford, and accompanied the engine with a load of some 30 tons, I think, and brought it into London. That is the only engine that I have ever seen at work. I promised the company when I went down, that I would keep a log of the proceedings of the engine, and let them have a copy of it, and also any observations which I might make upon it; but not being a professional engineer, I merely suggested some things, and made amateur observations. My principal object was, to see what the effect of the engine was upon the road, and how it was enabled to draw so great a weight as they said it would draw. I had previously gone much into the subject with several gentlemen who had suggested engines years before; I had talked a great deal to Mr. Brunel about them, and the conclusion which I always came to, and which Mr. Brunel said was a correct one, was that the resistance of the road to the engines which were then suggested was so great, that there would be no balance of power left to draw the carriages.

"The thing that struck me as being so excellent in Mr. Boydell's contrivance was, that the resistance to the forward motion of the engine was entirely destroyed by making the engine travel on an iron rail for nearly a yard, and when the wheel arrived at the point of that rail, it, in a most ingenious manner, lifted the rail it run over and laid down another for itself to run over. The bite which the engine had upon that iron rail was sufficient in most cases to propel the load which the engine had behind it, but where the wheel had a tendency to slip, the attachment of the wheel to the shoe was such that it could not slip any more, and the consequence was that the engine had the whole hold of the shoe upon the ground, and that shoe occupied an area of something like a thousand inches, so that the bite of the engine upon the ground was equal to the area of the shoe, and the wheel could not slide because the attachment prevented it, and in a most ingenious manner the engine continued to lay down one shoe after another as it wanted them.

"If the committee will allow me, I will suggest that there are two points that will arise before you, I think: the pressure on the road, and the injury by pressure to the road; the bite of the engine, and the injury by the bite of the engine: they are totally distinct things. This (*referring to the model*) is an iron rail, and that remains perfectly quiet on the road; the consequence is that let the load be what it will, the pressure on the road is diffused over the whole area of that shoe. The wheel then proceeds along the shoe that it has just laid down, lifts it up and then lays down another. Now with regard to the power of the propelling carriages, if this wheel had no shoes upon it, then you would have the bite of the width of this wheel acting upon a point upon the road; if that were skidded it would break the road, but if not, it would simply go forward, having previously tried to loosen the road, and perhaps have loosened it to some certain extent. Here, before this wheel can skid, it must drag the whole of that shoe along in that direction; and with enormous power and great resistance it does so.

"I have here a copy of my journal of a trial of Mr. Boydell's traction engine on its endless railway; and by extra sized spokes, there was attached to this a projecting iron all the way round, with teeth upon it facing upwards.

'The single power consisted of a pinion of ten teeth, working on the geared wheel of ninety-six teeth. The double power consisted of the same pinion working into another of twenty teeth which worked into the geared plate before mentioned. The front wheels, which work on a fixed axle, and lock by means of a perch bolt, are four feet six inches in diameter. The endless railway was removed from them.'

"By these front wheels the engine is guided or steered by means of a coach pole of nine feet in length, and a wheel and rudder chains conducted exactly as it is on board ship, the pole representing the tiller.

'The extreme pressure of steam is 70 lbs. on the square inch. The first point of draft is in a direct line with the driving wheel, the second and usual point 18 inches towards the near side of the engine, both through a strong beam of wood, bolted to the fire-box foot plate.'

"The reason of that was that the engine in going forward very much resembled a boat pulled with one oar; if you had put a rope from a boat pulled by one oar, over on this side, your boat would go nearly straight forward, because the backward draft would counteract the oar.

'An elevating screw working in the perch bolt raises or lowers the head of the boilers according to the ascent or descent of the ground, and is easily worked by the steerer. It has 16 inches of thread. The load consisted of articles which were to have been sent to London by railway; and the train of carriages which contained them was necessarily elongated by the requirements of the general turnpike acts, which restrict the weight of goods which shall be placed upon two or four wheels. The train was 95 feet in length, the engine 27, making together 122 feet long. One timber wagon, 4½ inch wheels, 5 tons 7 cwt.; one threshing machine, 2 tons; one ditto, 1 ton 17 cwt.; one wagon on 2½ inch wheels, containing a spare supply of water (never used), coals, coke, iron castings, &c., 4 tons; one agricultural engine (which was left at a farm near Newmarket), 3 tons; eight people (three of whom were in attendance on the engine and one on the train), chains and heavy attachments, to enable the wagons to draw each other, 5 cwt.; making together, 17 tons 1 cwt. (That was exclusive of the engine; then my report states this:)

On Thursday morning left Thetford at 10·3; supply of coke 10 cwt. 2 qrs. 12 lbs., ditto of coals (14 bags) 8 cwt. 2 qrs. 24 lbs.; tank full of water; one ton spare water. 10·5 A.M., started; 10·10, double power on in mistake, reduced to single. First mile, up hill, 1 in 24; 11·6, down hill, about 1 in 36, then up, 1 in 15; this tried the engine, the driver not being acquainted with her power; 11·15, stopped to show engine; 11·17, on again; 11·22, stopped at Elden for water; watered by a draw-well with a small bucket; 12·46 P. M., started round a right-angled turn in a 23 feet road without any difficulty; 1·15, stopped for horses.'

"That means, stopped for horses which were frightened. We had met several cart-horses; they had noticed it a little, but not enough to require us to stop. On going down hill, if the hill is sufficiently steep to allow the load to overtake the engine, we then put the skid on to some of the wheels of the load; but if the hill is not sufficient for that, we then let them go down quietly, and the engine itself is retarded by reversing the engine or throwing it out of gear, and letting it pump itself dry.

'At 1·16 we started; 1·43 stopped for heated driving-wheel (a new box had been put in that morning). The road had been loose, and made of flints; stopped for want of steam; coke had been tried, and smothered the fire; it was found to be too slow in burning; very bad parish road, but flat; 3·15 stopped for water at three-quarters of a mile from Milden Hall, Suffolk; cleaned ash-pan for first time; crowds of people and many horsemen, and some gigs following us, riding and driving close to the engine; 5·30, steep, bad road, over 1 in 18; engine very steady; about 2½ miles an hour; steering beginning to be affected at the inner or No. 2 point of draft; all this time single power used; 6·10 stopped at the "Red Lodge" inn; filled up water, 3½ miles from Milden Hall; cleaned fire-pan; 6·35, started from the "Red Lodge;" road very good, dry, hard, and smooth; 7·36, crossed railway arch up a gradient of 1 in 15, newly stoned with broken flints. The engine went very slowly, but did not stop; would not steer well; tended to the near water-course, and at last got into it. I stopped the engine to alter the power, when Mr. Boydell desired the single power might be continued, and he would get us out of the difficulty by altering (for the first time) the point of draft to that in a direct line with the driving-wheel, or No. 1. The engine then went on, steering quite well, and got out of the water-course; 8·15, arrived at Newmarket; went through the town, and left the train in a wide part of the road; returned to the town with engine, and placed it in the yard of the "Half Moon," a most awkward place to go into or out of with two horses in a wagon, as the entrance is narrow, crooked, and of a steep ascent. The engine went in and out without the least difficulty, although there were not 6 inches to spare at two points of a crooked turn. This distance is 22 miles, in consequence of going round to avoid an insecure bridge on the main road. We started at 10·5 A. M., arrived at 8·15 P. M.; time, 10 hours 10 minutes. Deduct actual stoppages, 3 hours 55 minutes, less stoppages than would have been necessary had tanks existed, 20 minutes; actual mercantile time, 6 hours 35 minutes, which is equal to three and four-tenths of a mile per hour for one day. Coal used (including a little coke), 10 cwt. 14 lbs., or about half a hundredweight to a mile. The coal was bad; the road generally on a rise, Newmarket being much above Thetford.'

"No accidents happened to vehicles or to other things, except such as I have read. We had not on any one occasion to take hold of a horse. Once or twice, near London, I went forward for the purpose of holding some carriage horses, but the coachman told me not to do so, as he would be able to manage them; the horses just stared at us, and then went on. We never attained five miles an hour, and I think I mention at the end of this report, that according to my idea, they never should go beyond that speed with that sized wheel. I should say that those engines ought not to travel, and would not travel at a greater speed than four miles an hour. The committee will bear in

mind that I have taken no further interest in this engine than to ascertain what effect it would have upon the roads and upon loads, under an impression that it might some day come into operation. I believe that the engine has been most materially altered and improved since the time of which I have spoken, at the suggestion of various officers of the Government who have seen it.

(Journal continued.)—'On Friday, May 15, 6 A. M., in Newmarket. Got up steam, and repaired the axles of the threshing machines, which, being of wood, were working badly all the day before; 7·15 started with the train; 7·56, a hill near the fourth milestone, nearly 1 in 19, the rest of the hill 1 in 12, about one furlong in length; not the least difficulty; two miles and a half per hour; road very good; 8·30, stopped at Six Mile Bottom for breakfast; filled up water; road good, but very undulating; the railway people telegraphed our starting from here up their line. The train was diminished in weight, by the loss of the agricultural engine of three tons. 9·15, started across the railway; road excellent, much downhill; stopped at Bourne Bridge for water; there being no convenient place to water, the engine was detached from the train, and turned at right angles down an embankment at 1 in 4; then on the bank turned again short to the right into the river, where, the tank being filled, the engine went through the stream, and up the upper bank, into the road, and, backing on to the train, started at 11·33. (That was a very severe test.) The bottom of the river was very slimy; we forced it over a piece of waste grass, and there was hardly room at the end of the bridge for the engine to go by; the shoes tore away the bank of the field, cut a great hole, turned the earth up, and exhibited most extraordinary power; it did so much mischief to the bank that we offered to pay the farmer, who was present, for putting it right again; but he very kindly said he would not think of taking any thing; 12·53, stopped for dinner at Chesterford, and filled up water; 2·13, started from Chesterford; 2·50, stopped at Littlebury to show the engine; 4 18, Newport; stopped for water; backed into a yard for it; stopped four times for horses.'

"All that country, it will be remembered, is very uninhabited, except on passing through the towns; we passed through several towns. Generally speaking, when we came to the towns we were inconvenienced by the number of people who were riding round us; we had forty or fifty people riding round us in one of the towns, and I was afraid one of them would be struck. Some of the horses made a great objection at first, but the gentlemen coaxed their horses up to the engine, and the thing ended in every one of them following us. The stoppage of the engine removed the difficulty. We never had any thing to do but to stop the engine, and then if a horse was frightened his rider would get down and coax him. The engine puffs off its steam like a locomotive, but the noise is not so loud. It struck me that the shoes on the wheel were the things that the horses did not like; they appeared to me more to dislike the sight of those shoes than they did the noise of the engine. The horses I speak of were hunters.

(Journal continued.)—'At 4·18, Newport; stopped for water; backed into a yard for it; stopped four times for horses. 5·8, went on; stopped very often to fill up water, fearing a want of accommodation. Windmill Hill very long and heavy, 1 in 15 in one place. 8·30, Bishop Stortford; put up for the night; turned off a 15-feet road at right angles with the whole train into the inn yard, which ascended steeply; stuck fast on a dung-heap, the rear wagon still overlying the turnpike road; put on double power and took in the whole train, dispersing the dung-heap all round; a shout from the bystanders, who had made up their minds that she was fast for the night; broke the steering-pole, and had it fished with iron plates. Saturday, May 16, 7 22 A. M., left Bishop Stortford; Spillbrook Hill 1 in 12; road broken; engine tended to near water-course. Altered points of drafts, and went on. 8·20, stopped to change drafts back again, tightened bolts on engine, and looked it over; stopped at Harlow Railway Bridge, took off engine and

filled up water; took in 12 cwt. of good coal, 20 cwt. having brought us from New-market, 41 miles, less than half a hundredweight per mile; road excellent. Bishop Stortford to Harlow, six miles. Station-master said we had arrived in half the time they had allowed us to do it in. Put the drag on to the timber carriage before it had reached the top of the incline; the engine took it all over with ease, notwithstanding the drag. (I merely did that to try the power of the engine on that piece of road.) Engine-driver quite acquainted with work and the engine; all went on smoothly. Harborough to Epping, 7 miles. 12·20 P. M., Epping; watered and dined; road hilly and rough from Harlow, but hard and dry; weather very fine; the road telling on the shoes.'

"That is a point which I will explain to the committee. In the shoes which we traveled with, instead of this bar being laid in the direction of the route, it was laid a little out of the direction of the route; I never could quite understand the reason for that, except that the attachment being outside, the shoe might not come perfectly square down; but when it came to lift the bar underneath, here, it was taken upon this point (*referring to the model*), and just as it left the road it gave a slight scrape upon the road. I was obliged to watch very narrowly to see what it was that had brightened the iron; that was a mechanical defect in the making of the shoe; it was not a necessary consequence of the principle of the construction of it. I think that this contrivance (*referring to the model*), as far as I can judge from merely seeing it, will entirely get rid of it, but I have never seen this wheel at work; I felt in my own mind that I could have got rid of it myself if I had made the shoes.

Journal continued.)—'The consumption of oil and grease very great. (I should mention that it was in consequence of the heating of the boxes; they were put in in a hurry the morning we started, and they were not perfectly true; it was a mere mechanical defect.) 1·37, started from Epping, taking one passenger, who was anxious to see the engine work; left the engine at a pond to water, when the men without orders put on a new finger in lieu of one broken; took in water; one tank full had brought us nine miles of very bad road. The road through Epping Forest and into Woodford very bad; no level; gradients from 1 in 18 to 1 in 40; the road broken up all over, sandy and heavy, with half settled material (round flint gravel, unbroken); 5·20, started from Woodford; 5·25, at bottom of the hill in the street, engine stopped, and on coming up to it saw two teeth broken out of the geared wheel, and the backward shoulder of the shaft saddle broken off beyond the bolts; 5·45, changed to the double power to ease the saddle; the bolt of the lever of the double power came off; there I left the train, within 200 yards of its destination, which was to be at Stratford. It was supposed the accident was caused by a momentary riding of the shoes from an improper bend in the new finger, but this was not confirmed by the engine-driver, who must have felt the shock; he only saw the tooth fall, and then the bit of the saddle fall at his feet on the foot-plate. The crank-shaft was slightly bent at the same time, yet nothing appeared to derange the motion of the engine. The road was good and slightly down hill, and on a turn. I was looking at it from a short distance, but did not perceive any peculiar motion. The heels and toes showed the effect of 85 miles of flint road, and one end of each rail was worn at the corner. The fingers were in some instances indented, but I do not think the actual loss of iron as much as would have been incurred on the shoes of the 14 horses it would have required to draw the train. There was not any perceptible wear in any other part of the engine. The coals averaged half a hundredweight per mile, and the pace averaged three miles and a half an hour. It would not be well to allow one of these engines to exceed five miles an hour. There was much less difficulty in descending hills and turning corners with a long train than was anticipated.'

"That is the whole of my report, which was merely intended for the company, and not for actual publication. I sent a copy of it, with the permission of this gentleman, to Colonel Tulloch, who had charge

of the carriage department at Woolwich, and he sent an officer to follow an engine which the company made for them, and I think that his report was very much like mine, the same kind of incidents happening all through."

Mr. M'Adam was subjected to a long examination by different members of the committee, for the purpose of eliciting further information on the points referred to in his journal. The most important parts of the information thus given were the following:—

"I saw one of these engines at Salisbury the following year, working a plough; and afterwards, at the Royal Agricultural Society, I saw it undergo a severe trial in the plough field. The principal part of the ground had been ploughed a day or two before. They got into a small hole in the ground, which was caused, I believe, by some chalk having been taken out; the wagon dipped into it, and the engine could not pull it out, the shoes tore up the soil and then the chalk, and the engine was very likely to bury itself. Mr. Boydell came to us; I was on the water tank; he took off the attachment and put on a long chain; the engine then lifted itself out of its own hole and got on to firm ground, and then it tore the tank, loaded as it was, out of the hole, and went up to the top of the hill.

"The horse power of the engine on the journey from Thetford was ten horses nominally. The effect of the wheels upon the road, was that the moment the shoe moved from the undue pressure on the piston, it then began to scrape the road, and did that kind of mischief which a horse's feet do when he struggles.

"I am of opinion that the damage which an engine and carriages drawn by the engine would cause to the road, would be considerably less than would be caused if the same weight were drawn by horses.

"The bursting of an engine is a matter so entirely out of everybody's control, that I would not say that the public would be perfectly free from danger of that kind; but it would be one of those points that the Board of Trade would have to look into very narrowly. The frightening of a horse is not, I think, a matter of so much consequence as should prohibit the use of these engines. I think that the use of them will obtain some day or other, and I think that some day or other the horses will become accustomed to them. We found that at first railways were a great nuisance to horses, so much so that in the General Railway Act, power was given to the Board of Trade to order a screen to be put up for the protection of public roads; during the early stage of railways, I was excessively particular about that, and insisted on screens being erected; some of those screens have since worn out; other railways have been made since, and I have endeavored to get screens put to them; but the very gentlemen who had been in the habit of using the road, have said that they did not want them; and I think myself, and I know from experience, that horses have become accustomed to railways, and I think that they would become accustomed to these engines in the same way; besides which, it is quite possible that the engines may be made much less objectionable than they are at present, by housing the wheels."

The remainder of Mr. M'Adam's evidence was directed to the consideration of the tolls that should be charged on such locomotive engines, and to the restrictions to which they should be limited as to use of wheels, speed, and general construction.

MECHANICS, PHYSICS, AND CHEMISTRY.

Opinion of U. S. Circuit Court, District of Columbia, on an Interference Case—being for "Thread Controllers of Sewing Machines."

Reported by HENRY HOWSON.

In the matter of Interference of A. BARTHOLF, Patentee, Appellant, and J. S. SWAN, Assignee of J. J. COUCH, Applicant and Appellee.	On appeal from the decision of Com. of Patents. At Chambers, March 8th, 1860.

G. D. SARGENT, New York, Counsel for Bartholf.
HENRY HOWSON, Philadelphia, Counsel for Swan.

The present contest involves an inquiry into the priority of invention of a certain improvement in the Thread Controllers of Sewing Machines, between A. Bartholf, patentee, and J. S. Swan, assignee of J. J. Couch, applicant. The patent of A. Bartholf was applied for on the 28th of March, 1859, and the application of Couch was made on the 17th of May, 1859. The *prima facie* case then is with the patentee, and must be overcome by the applicant with countervailing proof to show himself entitled to the prior right of discovery. To that end he relies upon the testimony of five witnesses, viz: C. H. Cornell, A. R. Payne, H. W. Marsh, J. Bond, Jr., and D. J. Levy. The inventor, Couch, has been adduced as a witness, and much stress has been laid upon his deposition by the Office, and by the council of the assignee, in his argument before the Office. But it is manifest that Couch is an incompetent witness. On several former appeals from the office, this question has been discussed by myself; and the other Judges of the Circuit Court upon like appeals have passed upon the same point, and if solemn decisions upon appeal from the Office, are to be recognised as authority in determining the rules of evidence applicable to its proceedings, it can no longer be regarded as an open question, and must be taken as definitely established that an assignor who has sold his invention is not competent as a witness for his assignee to prove priority of discovery, upon interference declared.

Disregarding then, entirely, Couch's deposition, it appears by the concurrent testimony of four out of the five witnesses above named, that as early as August, 1858, Couch, at the request of D. J. Levy —who was interested in the sale of the Bartholf Sewing Machines— and with the concurrence of Bartholf, set about inventing a new thread controller to supersede those previously in use, of which great complaint had been made; that he was very expert in all matters connected with sewing machines, being employed by Levy as an "adjuster," and that he devoted his attention to experiments in the line of such discovery, for two months or more, almost to the total neglect of his

regular business of "adjuster," and until his employers became impatient of the consumption of time. The deposition of A. R. Payne is most precise in fixing the time when the efforts of Couch ripened into invention. After narrating his first experiments with Exhibit 4, Payne, in answer to interrogatories 7th and 8th, goes on to describe a complete drawing and detailed explanation of the improvement as being made in September, 1858, at Mr. Taylor's shop. In answer to 8th cross-interrogatory, he fixes the time in September, by reference to the subsequent burning of the Crystal Palace, on the 6th of October. If Payne is to believed, the substance of the invention was then consummated by the drawing which exhibited every feature of the present patent accompanied by thorough explanation of its functions. But Payne goes further, and shows that this drawing was speedily followed up by the production of a model like Exhibit 6, early in October, or at least, within two or three weeks after the revelation of the idea. See his answers to interrogatories 13th, 14th, 15th, and 16th, and to cross-interrogatory 4th, and that it was afterwards attached to a sewing machine, interrogatories 17th and 18th. Cornell, in his answer to 9th interrogatory, fixes commencement of experiments in August, and 15th and 16th show that Bartholf was aware of Couch's operations, and that they were conducted at Bartholf's shop.—Levy's proof is to same purport; 7th and 8th interrogatories show that he had communicated to Bartholf the fact that Couch was experimenting, that Bartholf encouraged continuance of Couch's efforts, that the details were executed at Bartholf's shop; 12th interrogatory, that machines were furnished with the improvement attached early in November, (11th interrogatory,) and that during the whole progress of the invention, he had repeated communications with Bartholf touching the matter, (cross-interrogatory 4th,) and that in no instance did Bartholf assert any claim to the discovery for himself. Hampton P. Marsh also shows that Couch was experimenting in August, 1858, at Levy's request (2d interrogatory); and in answer to 8th and 9th interrogatories, he details the character of experiments Couch was making, together with the difficulties in the adjustment of the practical operation of the parts, and the declarations and statements made by Couch in the different stages of his progress, which declarations and statements accompanying the acts done, are evidence *per se*, and their nature and character such as to rebut the idea that Couch was already a pirate of Bartholf's perfected thought. This witness also shows, 9th, 10th, 12th, and 13th, that Bartholf was cognizant of Couch's operations; that as late as November, he characterized Couch's invention as a failure, and that he stated that he, himself, was getting up a new thread controller, which he explained to witness in a confused and imperfect manner, but sufficiently to show to the witness, who was already cognizant of Couch's advances, that the improvement, whatever it might be, was entirely different from Couch's. The witness, in answer to 4th cross-interrogatory, shows that he understood the subject and the character of Couch's invention fully at these conversations, as he says it was "before his eyes daily for two or three months, in all stages of its operation."

To oppose to these witnesses, each corroborating the other in every substantial particular, the patentee has adduced two witnesses. The principal one, Christian Ohle, testifies that he made for Bartholf about a year before (his testimony was taken on the 26th of September) the several models D, E, F, and G. Now, as Couch is positively shown to have begun experimenting in August, and to have shown his drawing in the month of September, something more than the indefiniteness of statement contained in the phrase, "about a year ago," stereotyped in the answers of an illiterate German, given by the mouth of an interpreter, to the questions touching each model in the succession of development, is necessary to overcome this positive testimony. By the positive testimony the burden of proving priority is shifted from the applicant to the patentee: and it is a mistake to suppose, as argued by the appellant, that the burden is taken off by the possession of the patent. The operation of that is destroyed by the antedating of Couch's witnesses, and once overturned its preponderance must be restored; not by itself, but by specific testimony from witnesses. It is by no means unreasonable, when a witness says that an event occurred about a year ago, to conclude that, that it happened a month less than a year, or a month more than a year, according as other circumstances give strength to the conjecture. Now, as this witness does not sever by more than two or three days any one of these models from the other, as we know that an urgent want for the improvement was felt in August, which was not gratified until early in November, we might safely conclude that he made nothing for Bartholf earlier than October.

But when we remember in considering his testimony, that the other witnesses all show that Couch had made great progress before that time; nay, had developed the idea fully, although the nice and delicate operation of final adjustment of parts in their happiest relations had not been made, that his labors were well known to Bartholf, and to great extent were carried on in his shop; the fact that this German afterwards made these models for Bartholf, proves nothing towards the establishment of his claims to discovery.

In this connexion, it is not only significant, but furnishes the strongest inference against the pretensions of Bartholf, that Henry Ehrenfeldt, a skilful mechanic and foreman of Bartholf, under whose immediate eye Christian Ohle worked; who gave Ohle his directions frequently; who from time to time made Couch's models, or altered them, who must therefore have known what agency Couch had, and what knowledge Bartholf had of this invention, whose reluctance to testify against Bartholf, is apparent on the depositions; was not interrogated by Bartholf on this subject. He surely could speak with better means of knowledge than any other person of his employer's discoveries; and if he had not knowledge, it was his employer's duty to let that fact appear to save himself from the imputation that the witness could speak more than he was desirous to have revealed.

Besides Ohle was called for the patentee William H. Towers, a witness whose interest as a stockholder in the company engaged under Bartholf's patent, together with his manifest leaning against, and con-

tinued effort to disparage Couch, require his testimony to be taken with very many grains of allowance. Upon the question of priority, he proves, 9th, 10th, and 13th interrogatories, that "about a year ago," he was in the shop, and that Bartholf made certain experiments with Exhibit D and E, and that he himself suggested that it would be better to attach Exhibit E to the needle arm. Whatever these experiments were, it is at least certain that the detail given by this witness does not describe the completed improvement as it appears in the patent, and as collected from his deposition does not amount to a complete invention. But this witness claims that the whole merit of the invention lay in the mere fact of attaching this lever (E) to the needle arm, and that he himself was, therefore, the real inventor of whatever improvement was made; and J. Bond, Jr., in answer to 12th interrogatory, says also that Bartholf claimed that Towers had suggested that point, and that as the invention depended entirely upon the position of the lever on the needle arm, Towers, if any one, was entitled to the patent for this discovery.

The testimony of the witness, Bond, relates to a period commencing with January, 1859. In his 8th and 9th answers, he discloses the remarkable fact that Bartholf, when called upon to give the necessary explanations about adjusting machines, with the thread controller now in dispute upon them, referred the witness for information to Couch; although he stated at the same time, that Couch was in the employment of an enemy, and would probably refuse him the desired information.

In his 10th and 11th answers, this witness reveals a still more remarkable fact, that Bartholf at this time did not comprehend the nature and character of the invention he has since patented and claims to have originated. In the face of such a mass of testimony, the pretensions of the patentee cannot prevail for an instant. It is established beyond reasonable doubt that Couch made the invention in question in the month of September, and brought it to perfection, and had it put upon machines in marketable shape in November, and there is no testimony at all reliable to connect Bartholf with the discovery.

The foregoing remarks dispose of the first and third reasons of appeal which present in slightly varied forms the question of priority of invention as described in the specifications of the respective parties. There is another (the second) reason of appeal, which alleges that certain thread controllers produced by Bartholf, marked Exhibits (B,) (H,) and (I,) contained the same invention as that described in the Patent of 17th May, 1859.

Charity requires us to rejoice that these exhibits have been produced and that the patentee contends for their covering the invention in dispute. For it is only in that averment and his sincere belief of its correctness that he can find justification for claiming a discovery which he must have known, looking only to the other testimony in the cause, was rightfully the property of another. In the legal aspect of the case, however, these exhibits could only avail to show that neither the applicant nor the patentee is entitled to a patent, inasmuch as the in-

vention embraced by those exhibits were sold to the witness, and over more than two years before either of the present claims was filed, and since that the invention had become public property.

The objection comes with an ill grace from a patentee; and it may well be doubted whether, having applied for a patent with the knowledge of this sale of the invention more than two years before, locked in his breast, he can be heard to make a defence of the kind against an applicant proving priority upon the well settled maxim—*nemo allegans suam turpitudinem audiendus est.* But passing by that objection, the testimony which the patentee has put upon the record for the purpose of establishing identity between the inventions (I refer to the testimony of the witness Brown) has failed entirely to bring my mind to that conclusion, while the testimony of Ehrenfeldt and Mason is quite the other way. And an inspection of the models, shows very clearly that friction, regular, constant, and capable of being controlled, and nicely adjusted to the delicate operations of a thread controller, cannot be imparted by the head of a screw pressed directly upon the fulcrum of a lever as shown in Exhibits B, H, and I, and that in view of the operation to be performed, the one arrangement is no equivalent of the other. Without elaborating this matter, already sufficiently apparent to the Office, I conclude that there is nothing in the objection.

Now, for the reasons aforesaid, I hereby certify to the Hon. Philip F. Thomas, Commissioner of Patents, that having assigned the 27th of February, 1860, at my Chambers, in Washington City, for hearing the said appeal, and the applicant having been heard by counsel, I have considered the reasons of appeal, the response of the Office to those reasons, and examined all the testimony, and carefully pondered the arguments of the parties, and I am of opinion that there is no error in the judgment of the Commissioner upon any one of the reasons of appeal filed. I therefore affirm the judgment of the Office, and direct that a patent be issued to J. S. Swan, assignee to J. J. Couch, for his improvement in Sewing Machines, according to his claims and specification as filed.

Done at Washington City, this 8th of March, 1860.

Wm. M. Merrick,
Assistant Judge U. S. Circuit Court,
of the District of Columbia.

On the Oxides of Iron, considered as a means of conveying the Oxygen of the Air to combustible matters. By F. Kuhlmann.*

[FIRST PART.]

In the study of the phenomena which occur in the superficial strata of the globe, no source of action must be neglected; for however weak it may be, still, when assisted by the succession of ages, it may produce the most important modifications in the constitution of the globe.

The sources of action which it is especially important to probe to

* From the Lond. Chemical News, No. 2.

the bottom, are those in which the principal agent intervenes, not by its constituent principles, but only as a sort of carrier, to transport certain bodies and place them in conditions favorable to their combination with others.

When, in our manufactories, we make use of the binoxide of nitrogen to transport the oxygen of the air to sulphurous acid, and cause the latter to pass to a more advanced state of oxidation; or when we employ acetic acid intermediately to fix the oxygen and carbonic acid of the air upon lead, we make use of one of those levers which, in nature, give rise spontaneously to the most varied phenomena.

For many years I have paid attention to these successive and slow actions, and I have indicated their importance in various memoirs. Thus I have called the attention of chemists to the part played by oxygen in the phenomena of color in plants, and in their decolorization by sulphurous acid, and by putrefactive fermentation. I have investigated the properties of certain bodies capable of serving as reservoirs of oxygen to convey it to oxidizable bodies, adding some facts to the important observations of M. Schönbein. My researches upon the efflorescences of walls, have led me to a thorough investigation of nitrification, in which slow and successive transformations play such an important part. This investigation, which includes the action of spongy platinum upon various gaseous mixtures, led me, as early as 1846, to show that there is an intimate relation between nitrification and the fertilization of soils. I have since explained how ammonia, the immediate product of the decomposition of animal matters, passes, under the influence of aërated water and porous bodies, to the state of nitric acid or of nitrate of ammonia, and how in the lower parts of the soil the nitric acid formed, being deoxidized by putrefactive fermentation, is brought back to the state of ammonia. I have also shown how ammonia intervenes, without decomposition, in transporting nitric acid to lime and magnesia, when the carbonates of these bases form constituent parts of arable soils, just as carbonate of ammonia intervenes to displace the silica of the alkaline silicates, giving rise to siliceous petrifactions.

Lastly, with regard to industrial applications, I have shown how a limited quantity of carbonate of potash or soda might serve to precipitate indefinitely carbonate of lime in a pulverulent state from the chalky water which is used in steam boilers, thus preventing those incrustations which are so injurious to boilers.

A particular circumstance has lately recalled my attention to these slow and successive phenomena, in which transporting agents intervene.

Alteration of the Timbers of Ships.—In passing through the dockyards at Dunkirk, I had the opportunity of examining the fragments of a ship in course of being broken up, and I was much interested in observing a great alteration of the planks at all points where the wood had been traversed by iron nails or bolts. At a distance of several centimetres from these points the wood was half carbonized by a sort of eremacausis; the portions thus burnt were detached by a slight effort, the fibre of the wood having lost all its elasticity. Nothing of

the kind was produced where the wood had been fixed by means of copper or wooden bolts. I have learned from M. Frénneville that this phenomenon is general; that it is averred to be the cause of the rapid destruction of the hulls of wooden ships, and that for this reason it deserved to be thoroughly investigated.

The explanation which first of all presented itself to my mind, consisted in assuming that the iron, under the continuous action of the sea water and air, becomes rapidly oxidized, and that the oxide formed when in contact with the wood undergoes an opposite action and passes under this deoxidizing influence from the state of sesquioxide to that of protoxide. The protoxide again takes up oxygen from the air, and transports it again to the wood, causing this continually to undergo the alterations to which I have referred.

In this way iron would fulfil with regard to wood, and consequently to combustible matters in general, the part played by binoxide of nitrogen in the manufacture of sulphuric acid, by acetic acid in the manufacture of white lead, &c. The sequioxide of iron would undergo modifications analogous to those to which nitric acid is subject in arable lands, where under the influence of the putrefaction of organic matters, it passes to the state of ammonia, to regenerate itself again at the expense of the oxygen of the air or of oxidizing bodies.

It is, moreover, easy to convince oneself that it is in the properties of the iron that we must seek for the cause of the alteration of the wood; for this alteration takes place at all points where the oxide is present; it extends parallel to the fibres of the wood, as far as the iron has been capable of transportation into its thickness by the action of some solvent.

If the alteration was confined to oak timber, we might inquire whether tannin may not have had some influence in the reaction; but the same phenomena are presented by deal. It is therefore in the oxide of iron alone, whatever may be the cause of its development, that we must seek for the key of the alterations observed.

I have also ascertained that the oxide of iron fixed in the wood is not at the same degree of oxidation throughout the mass. In the state of sesquioxide it is in greater proportion in the superficial layers of the wood than in the centre, where the presence of protoxide of iron may be easily detected by ferrocyanide of potassium.

The preceding explanation supposes that sesquioxide of iron may be partially reduced merely by contact with organic matters not yet arrived at their putrefactive decomposition; the following are the results of some confirmative experiments:—

I. Hydrated sesquioxide of iron agitated in the cold with variously colored solutions causes their decolorization very energetically by the formation of *lakes*. These lakes most frequently contain iron at the minimum of oxidation, the partial reduction of the sesquioxide taking place by the oxidation of the coloring matter. The colors upon which the action of sesquioxide of iron is most energetic are those of logwood, Brazilwood, cochineal, turmeric, and mahogany. The deoxidation is almost null with indigo and litmus.

These results being capable of explanation by the great affinity for oxygen possessed by certain coloring matters in the state in which they occur in plants, I had recourse, in other experiments, to organic matters presenting a closer resemblance to wood in their composition and properties.

II. Solutions of cane-sugar, glucose, and gum were boiled in presence of hydrated sesquioxide of iron. The reduction was very energetic with glucose, less so with cane-sugar, and weak with gum. With glucose the reaction is perceptible even in the cold.

III. Lastly, I tried the action of oil of bitter almonds upon hydrated sesquioxide of iron dried at 212° F. The reaction took place in a sealed glass tube which was kept at a temperature of 212° F. for ten hours. In this experiment a large quantity of protobenzoate of iron was produced. A portion of the oxide remaining undisturbed was in the state of protoxide.

We may add that the phenomena of destruction of organic matter in contact with oxide of iron, without the intervention of the deoxidizing gases of putrefactive fermentation, are going on daily before our eyes. There is no one who does not know from experience that after one or two washings, spots of iron mould in linen or cotton stuffs are replaced by holes; printing with iron presents the same defects, and too often stuffs dyed black acquire a brown tint; when, as they lose their strength, they are suspected of having been *burnt in dyeing*.

I shall add the following facts observed during a long experience of bleaching by one of my pupils, M. Dietz:—

I. When the inner walls of the sheet iron washing troughs are laid bare by the removal of the calcareous incrustations which usually cover them, and the iron comes into direct contact with the stuffs, the latter become covered with rust in the upper parts to which the air has free access, and in all the portions so spotted their alteration becomes inevitable.

II. When the common stuffs manufactured with the cotton waste contain scales of iron, produced from the cards or other parts of the machinery, this iron becomes rusted during the bleaching operations, and in four or five days the stuff is in holes wherever the rust was deposited.*

It appears evident to me that this energetic action of sesquioxide of iron may be one of the causes of the spontaneous inflammations so frequent in the waste of cotton and wool. If the oxidation of the oils with which these materials are often impregnated be a circumstance in favor of these inflammations, the place where the oxide of iron has been deposited is probably the point of departure of the fire.

The results of my experiments, and all these facts of daily observa-

* M. E. Schwartz, who has paid attention to the causes of the alterations which I have indicated, asserts that, in dyeing, the protoxides of iron and manganese which are deposited upon the tissues and oxidised with the view of obtaining sesquioxide of iron and binoxide of manganese often cause "the oxidation of the tissue itself upon which they are applied," and he establishes this proposition,—"*that a substance in becoming oxidized also causes the oxidation of the body in the presence of which it is, even when the latter is not oxidizable in an isolated state.*"—(Persoz, *Traite de l'Impression des Tissus*, i, p. 311.) I think that the considerations upon which I have entered will not bear any doubt in the minds of chemists as to the actual cause of the alteration of tissues. For the oxidation *par entrainement* assumed by M. Schwartz, I substitute a succession of reactions which has no limit except the destruction of the combustible material.

tion, appear to be conclusive in making chemists to admit that sesquioxide of iron may serve to convey the oxygen of the air to organic matters, and thus hasten their destruction. This oxide acts to a certain extent as a reservoir of oxygen, filling itself at the expense of the air in proportion as it empties itself for the profit of the combustion of combustible bodies.

As regards the alteration of the timbers of ships, now that the causes of this alteration are indicated, it will be sufficient, no doubt, for its avoidance, that the iron nails and bolts should be tinned or coated with zinc, or replaced by nails and bolts of copper.

In the second part of this Memoir, I shall take up the agronomic and geological questions attaching to it.—(*Comptes-Rendus*, 1859, p. 257.)

For the Journal of the Franklin Institute.

Remarks by MR. ARCH. WILSON, *of New York, on his Patent Gas Lighter, made before the Franklin Institute at their Stated Meeting, March* 15*th*, 1860.

To render the application of electricity to the lighting of gas practically a success, several things are required, the want of any one of which is sure, sooner or later, to disappoint both the experimenter and the public. The mode of application must be simple, easy to adjust, efficient, reliable, and economical. The method or plan that shall claim public patronage must combine all these requisites. Science seems to have demonstrated that electricity is susceptible of such an application but upon two general principles—one is by using the current to heat a platinum wire; the other to generate the electric spark. While it has been as universally admitted that the latter would most fully furnish all the requisites for success if it could be applied, yet, with the exception of very limited experiments in the laboratory or lecture-room, it has been as universally abandoned as impracticable for the following reasons supposed to be insurmountable: First, the current which generates the spark is of such extreme intensity, that it has been deemed impossible so to construct a long circuit as to protect or control the current for any great distance, owing to its tendency to fly off to surrounding objects. And, second, the instruments heretofore used to generate the spark have been so extremely susceptible to atmospheric changes as to become entirely inoperative in a moist atmosphere. Hence, experimenters in this direction have given their attention and skill almost exclusively to the application of the heated wire to this purpose. Still, the difficulties which attend this plan were so early presented, and so clearly brought out by the late Dr. Hare, of your city, that it would seem that the most unscientific experimenter must have been convinced of its impracticability beyond a very limited success.

These difficulties are, first, the current used to heat the wire is a quantity current, and generated by a voltaic battery. Consequently the entire source of the power is constantly decreasing in efficiency and wearing away under the action of the acids upon the metals used. Frequent repairs, therefore, become necessary. Then, as the number

of wires to be heated is increased—and there must be one of these wires over each burner—or the length of the circuit is extended, the source of the power must be increased also, till, where a large number of burners is used, and the current is to be passed through a long circuit, the battery becomes immensely increased and the outlay to replenish it and keep it in repair is correspondingly large, as five hundred pairs of plates, other things being equal, wear out just as rapidly as five pairs do. Hence, it becomes a very great desideratum, economically, to reduce the number and size of the plates as much as possible and yet produce the desired result.

Other difficulties, quite as serious practically, are continually met with in the wires to be heated; the least variation between them, either in their length, thickness, or the quality of the metal, being sufficient to prevent the gas from being lighted, owing either to the fusion of some of the wires by the current, or the failure to heat others sufficiently. And then these wires, as one must be placed directly across the top of each burner and stand permanently in the jet of burning gas, soon become encrusted with a thick coating of soot. In this condition, the action of the battery must be continued till both the wire and its coating of soot are heated to the point for igniting the gas; or if the battery has fallen below the required power to heat these, it fails altogether to light the gas. In either of these cases the room is unavoidably being rapidly filled with the escaping gas. The length of time required to coat these wires with soot will vary with the purity of the gas used. Another difficulty with such wires is, that though the battery-power might be sufficient to heat the wires, yet a gust of wind or a too strong pressure of gas striking them will often cool them down below the igniting point, and time must be given for the gust of wind to cease or the gas to be regulated to the proper pressure.

This plan of lighting gas by the heated platinum wire demands, in all cases, an absolutely unbroken metallic circuit. The least break in the circuit, though it amount to no more than the hundredth part of an inch, is amply sufficient to prevent all action in the battery and to leave a room or street in total darkness till such break is repaired; and this break can be repaired only by searching for it through the entire length of the circuit, as this can give no sort of signal to inform the operator where the break may be found. Though this plan may be adjusted with the greatest exactness, and even so as to do the work, with the greatest care of the operator, for several days or weeks; yet, in an instant, from some unaccountable variation in the action of the battery, a wire is fused and the circuit broken, thereby producing the most serious annoyance at the most important junctures.

The difficulties of this plan, so clearly brought out by Dr. Hare and others, have led all scientific experimenters to abandon the hope that it can ever be applied with any permanent and satisfactory result, and to base their expectations and hopes upon the use of the electric spark for this purpose, should an instrument not liable to change with atmospheric changes and of sufficient power ever be invented. The spark, as it results from great intensity in the current and leaps through free

air, does away at once with all necessity for preserving an unbroken metallic circuit, since its success in gas lighting depends upon a break over each burner; and also does away with the small platinum wires to be heated over each burner. It was not until the discovery of the spark from the induced current generated by an instrument which was in no sensible degree susceptible to atmospheric changes, that a current seemed to have been discovered that could be relied upon permanently to do this work. It was an examination as to the reliability and efficiency of this current that led me to the conclusion that in it was contained all the power that the most enthusiastic experimenter in this direction could desire. It has been with this current, mainly, that my experiments have been made, and it is my application of this current to the lighting of gas that I desire to exhibit before you this evening. Before making my experiments I will, with your permission, give a short explanation of my mode of applying this current. I think I shall be able to satisfy you that the number of burners to which I apply it this evening will exhaust but a very small portion of the power which I have here. I have connected my insulators and wires with the ten burners of your room and with the fifty-six burners of the chandelier which I have suspended from the centre of the room. In order to save the power of my current and use it with the utmost efficiency, I insulate all the burners in the room, by placing between the burner and the gas pipe two small pieces of some non-conducting material, in this case hard rubber, which bears a high degree of heat. The lower piece of rubber is furnished at one end with a female screw and fitted to the gas pipe or fixture; the other end has a male screw and is fitted to the burner. Before putting the burner on, I slip over the male screw of the insulator a looped copper wire—in this case No. 24—and then another small piece of insulator; after which I screw on the burner. The looped wire is then bent over so that the end comes just outside the jet of gas and within an eighth or a sixteenth of an inch from the top of the burner. I then connect a looped wire with a burner or two looped wires and two burners in succession till all are connected, and these with my instrument; when my circuit is complete, with each burner making part of the circuit. For the sake of showing the safety with which I can pass over even the smallest wire any amount of current which my battery and coil can generate, my circuit wire is in this case No. 36 uncovered copper wire. My connexions are now complete, and by means of the insulators at each burner the current will be made to pass around on the top of the burners, and as the electricity leaps across the space from the looped wire to the burner, the spark will appear and ignite the gas with the rapidity of lightning.

The electro-motive power which I use is a voltaic battery and Ritchie's improved inductive apparatus. My battery by itself, and when applied to the heating of platinum wire to show its efficiency, is barely sufficient to heat wire enough to light two burners. If applied to a short piece of my conducting wire, No. 36, it would instantly burn it off. When connected with my coil it will not heat the smallest platinum wire that I have been able to obtain, and will pass with perfect safety

over the smallest conductor. And yet I think I shall be able to show you that this current from a battery so inefficient in itself, will, with the coil, ignite 500 or even 1000 jets instantaneously; thus increasing my battery power several hundred fold. By bringing the pointers at the poles of my coil within one inch and a quarter of each other and allowing my wires to be connected with the chandelier, I think I shall show you that this current, rather than leap across a single space of free air one inch and a quarter long, will leap across the fifty-six spaces on the chandelier whose aggregate distance is eight inches. I shall also show you that if I break the wire entirely away from one pole of the coil, I shall yet light a large proportion, if not all, of the jets on the chandelier. Or if a break accidentally occurs anywhere along the circuit, the spark will at once notify where the break is by the smart cracking sound which it will give.

The coil, which is the main source of the efficiency of this plan, does not wear out and needs no replenishing. The only part that does wear out and that can require expense to repair, is the very small battery which I use, which can scarcely require the outlay of a shilling per month to keep in repair. The acid in my battery I have often reduced to 1 part to 24 or 30 water, using Smee's battery. No variation in the battery endangers the circuit, and the whole arrangement is so simple that any body can keep it in repair.

With 5 Smee's cups, plates 8 inches square and a very weak acid, I have sent this current over 600 miles of telegraph wire, without the aid of a single cup of a relay battery, and obtained a spark 2½ inches long. So that, had I a wire connected with all the street lights of your city and ending at my instrument in Wall Street, New York, I believe I could light your whole city from my office.

A gust of wind or high pressure of gas striking on this spark has no other effect than to increase its size and thereby add to the certainty of igniting the gas.

The advantages of this method are then:

1. It avoids the extreme care required in other plans to preserve an unbroken metallic circuit.

2. No degree of variation in the battery-power will endanger the conducting wires though reduced to the smallest size.

3. The waste of the battery is reduced many hundred fold and the expense of keeping in repair is proportionally decreased, while its efficiency is as greatly increased by connecting with the inductive apparatus.

4. If a break in the circuit occurs out of place, a large proportion of the jets will still be lighted, while a smart cracking sound will at once direct the operator to the place where the break may be found.

5. No pressure of gas or gust of wind can affect the efficiency of the spark to do its work.

6. The smallest spark is amply sufficient to ignite gas.

7. This current is readily controlled, as is proved by its passing over 600 miles of telegraph wire with ordinary insulation—a length of circuit more than sufficient to reach every public light in the largest city of the Union.

8. It insures great saving of gas, from the fact that rooms need not be lighted till the moment they are wanted.

9. By removing all necessity for the use of matches and torches about buildings it affords great security against fire.

10. The conducting wire may be passed through the most inflammable materials with perfect safety, as the current used will not heat the smallest wire.

11. Its simplicity enables any one to operate and keep it in repair.

For the Journal of the Franklin Institute.

Particulars of the Steamer San Carlos.

Hull built by W. Simons & Co. Machinery by Randolph, Elder & Co., Glasgow. Intended service, Valparaiso to Panama.

Hull.—

Length on deck,		210 feet.	
" water line,		192 "	
Breadth of beam,		30 "	
Depth of hold to spar deck,		18 "	
Frames—shape L; $4\frac{1}{2}$ ins. × $3\frac{1}{2}$ ins. × $\frac{1}{2}$-in., and 18 ins. apart.			
Bulkheads,	Four.		
Diameter of rivets, $\frac{5}{8}$ and $\frac{3}{4}$; double riveted.			
Independent steam, fire, and bilge pumps,	Three.		
Length of engine space, and 140 tons coal,		34 "	6 inches.
Draft forward and aft,		11 "	10 "
Tonnage,	Hull 460, engine room 390, = 850.		
Contents of bunkers in tons,	140.		
Speed, with and against tide,	$11\frac{3}{4}$ knots.		
Masts, two—rig, Brig.			

Engines.—120 H. P. nominal—double cylinder.

Diameter of cylinders,	two of 53 ins. and two of		31 inches.
Length of stroke,		2 feet	11 "
Average revolutions,	48.		
Weight of engines,	70 tons.		

Boiler.—One—Horizontal tubular, with spiral tubes in chimney.

Breadth of boiler,		12 feet	6 inches.
Height " exclusive of steam chests,		24 "	
Weight " with water,	55 tons.		
" " without water,	32 "		
Cubic feet in steam chests,	200.		
Number of furnaces,	1.		
Breadth "		11 "	
Load on safety valve, per sq. inch,	50 lbs.		
Gross indicated power,	500.		
Heating surface,	2200 sq. ft.		
Diameter of chimney,		5 "	3 "
Height "		22 "	
Consumption of coal per hour,	1120 lbs.		

Propeller.—

Diameter of screw,		10 feet	6 inches.
Pitch "		13 "	4 "
Length of blades, Griffith's,		1 "	2 "
Number "	2.		

Remarks.—Cylinders steam jacketed. Gearing two to one.

This vessel has engines and a boiler of the peculiar arrangement of Messrs. Randolph, Elder & Co., of Glasgow, who seek to attain

economy in the consumption of fuel by superheating the steam from the boiler in its passage through a spiral coil of tubes located in the chimney and smoke-pipe. (See *Artizan* for March, giving a drawing of the arrangement adopted in the *Valparaiso.*) Also, by using two steam cylinders of different capacities in *lieu* of one, into the smaller of which the steam is first admitted, expanded three times its volume, then admitted into the larger cylinder having a capacity of three times the other, when it is again expanded three times its volume, making the whole expansion nine times its original volume.

By this machine, the designers have clearly demonstrated that a very essential saving of fuel may be attained in the case of the vessel whose dimensions and details are here given. Her consumption of fuel upon her trial, was shown to be but 2·1 lbs. per horse power per hour.

So soon as I obtain further particulars of the vessels now building by this firm, I propose to again refer to this arrangement.

Date of trial—February, 1860. C. H. H.

CORRECTION.

Steamer Great Eastern.—In the details of this steamer published in the December number of the *Journal*, there were the following errors and omissions, which I beg leave to correct and add.

Water-wheel engines; area of grate surface, 816 square feet instead of 370.

Propeller engines; area of grate surface, 1305 square feet instead of 406.

Additional details; decks, six forwards, five aft, and four amidships. Weight of water wheel engines and boilers, 1250 tons. Capacity for cargo, 6000 tons. Iron in hull, 10,000 tons. Plates, 30,000 in number. Rivets, 3,000,000.

Steamer Adriatic.—In the details of this steamer published also in the December number, there was an error in the length of the boiler tubes. The correct length is 5 feet.

Additional details; area of grate surface, 1056 feet, and the number of engines, two.

C. H. H.

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*On the Employment of Carbon as a means of Permanent Record.**

By John Spiller, F.C.S., of the War Department.

The undoubted superiority, in respect to the quality of permanence, of ordinary printed characters in comparison with the several kinds of manuscript, renders it desirable that efforts should be directed to the possibility of availing ourselves of the unalterable nature of carbon, the principal ingredient in printer's ink, with a view to the employment of the same as a substitute for the tannate of iron in the ordinary black writing fluids. The want of permanence constantly attributed to the latter, and borne out by the inspection of manuscript deeds of comparatively recent date, seems inherent to an ink which depends solely for its permanence on a weak chemical affinity exerted between the oxides of iron and the product of a vegetable infusion, which, left to itself, is constantly undergoing change. Hence the application of dilute acids, both mineral and organic, is sufficient either to obliterate

* From the London Chemical News, No. 2.

or render illegible the characters written with such ink; whilst its composition makes it liable to fade under circumstances no more unfavorable than that of exposure to a damp or impure atmosphere.

On the other hand, the imperishable nature of carbon, in its various forms of lamp-black, ivory black, wood charcoal, and graphite or black lead, holds out much greater promise of being usefully employed in the manufacture of a permanent writing material; since, for this substance, in its elementary condition, and at ordinary temperatures, there exists no solvent nor chemical reagent capable of effecting its alteration. Carbon is destroyed, or rather oxidized, only by fire, and by the long continued action of the strongest acids; only under such circumstances, therefore, as the tablet of prepared vegetable or animal substance is itself unable to withstand. Provided, then, that efficient means can be adopted for securing its perfect adhesion to the surface, or passage even into the pores, of the paper (a point not sufficiently considered, perhaps, in the production of the so-called permanent carbon photographs), there seems every probability of a carbon pigment resisting the effects of time and other corrosive influences better perhaps than any other substance, elementary or compound, which is likely to be brought into comparison with it. The perfect state of preservation of the early engravings and pages of printed type corroborates this view; they exhibit in some instances evidence of destruction by decay of the paper itself, rather than that of the carbonaceous material forming the subject of the picture.

The suggestion relative to the mode of applying carbon to these purposes, which it is intended more particularly now to enunciate, depends on the fact of the separation of carbon from organic compounds, rich in that element, sugar, gum, &c., by the combined operation of heat and of chemical reagents, such as sulphuric and phosphoric acids, which exert a decomposing action in the same direction; and by such means to effect the deposition of the carbon within the pores of the paper by a process of development to be performed after the fluid writing ink has been to a certain extent absorbed into its substance. A system of formation by which a considerable amount of resistance, both to chemical and external influences, appears to be secured. An ink of the following composition has been made the subject of experiment:—

Concentrated sulphuric acid, deeply colored with indigo, ...	1 fluid ounce.
Water, ...	6 " "
Loaf sugar, ...	1 ounce troy.
Strong mucilage of gum arabic, .	2 to 3 fluid ounce.

Writing traced with a quill or gold pen dipped in this ink dries to a pale blue color, but if now a heated iron be passed over its surface, or the manuscript held near a fire, the writing will quickly assume a jet black appearance, resulting from the carbonization of the sugar by the warm acid, and will have become so firmly engrafted into the substance of the paper as to oppose considerable difficulty to its removal or erasure by the knife. On account of the depth to which the written characters usually penetrate, the sheets of paper selected for use should be of the thickest make, and good white cartridge paper, or that known

as "cream laid," preferred to such as are colored blue with ultra-marine, for in the latter case a bleached halo is frequently perceptible around the outline of the letters, indicating the partial destruction of the coloring matter by the lateral action of the acid.

The writing produced in this manner seems indelible; it resists the action of "salts of lemon," and of oxalic, tartaric, and diluted hydrochloric acids—agents which render nearly illegible the traces of ordinary black writing ink; neither do alkaline solutions exert any appreciable action on the carbon ink. This material possesses, therefore, many advantageous qualities which would recommend its adoption in cases where the question of permanence is of paramount importance; but it must, on the other hand, be allowed that such an ink, in its present form would but inefficiently fulfil many of the requirements necessary to bring it into common use. The peculiar method of development rendering the application of heat imperative, and that of a temperature somewhat above the boiling point of water, together with the circumstance that it will be found impossible with a thin sheet of paper to write on both sides, must certainly be counted among its more prominent disadvantages.

Though not perhaps capable of employment on the animal tissues, vellum and parchment, there is every probability of its successful application in connexion with the new material produced by the action of strong acids on paper, and known under the name of vegetable parchment.

Royal Arsenal, Woolwich, Dec. 5th, 1859.

Extract of Hops. Houblonine.

M. Ramont asserts that he has obtained by treating hops by boiling water in a close vessel, an extract which he calls *houblonine*, which contains all the active, aromatic, bitter, and astringent principles of the hops; and that by means of this extract, the manufacture of ale may be greatly ameliorated.—*Cosmos*, March, 1860.

Description of Brown & Sharpe's American Standard Wire Gauge.

To the Editor of the Journal of the Franklin Institute.

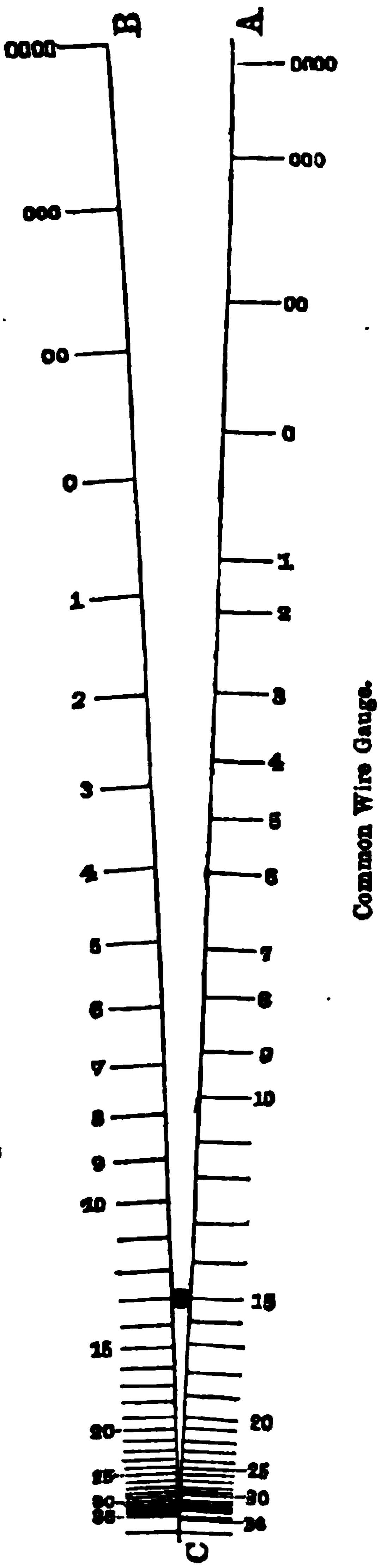
Sir:—Lately, upon examining some boilers that had been ordered to be made from iron of No. 4 gauge, or about ¼-inch thickness, the plates were found to be only No. 6, or two numbers less than they were expected to be; objection being urged, the constructor produced the gauge for his justification, but instead of its being the time-honored Birmingham standard gauge, it proved to be one styled "American standard wire gauge," made by Brown & Sharpe, of Providence, R. I., and which, it was said, had been adopted by many of the plate manufacturers of the United States. Now, the gauge as a measurer of boiler plate is new to the writer who has frequently under his notice the thickness of such plates, and it is desired to obtain, through the medium of

your pages, some expression of the practice or the opinion of the various plate makers upon this subject.

The subjoined diagram, table, and their explanations are taken from a circular issued by Brown & Sharpe and tell their own story.

No. of Wire Gauge.	New Standard. Size of each Number in decimal parts of an inch.	New Standard. Difference betw'n consecutive Nos. in dec. parts of an inch.	Old Standard. Size of each Number in decimal parts of an inch.	Old Standard. Difference betw'n consecutive Nos. in dec. parts of an inch.
0000	·460		·454	
000	·4096	·0504	·425	·029
00	·3648	·0448	·380	·045
0	·3249	.0399	·340	·040
1	·2893	·0356	·300	·040
2	·2580	·0313	·284	·016
3	·230	·028	·259	·025
4	·205	·025	·238	·021
5	·1819	·0231	·220	·018
6	·162	·0199	·203	·017
7	·1443	·0177	·180	·023
8	·1285	·0158	·165	·015
9	·1144	·0141	·148	·017
10	·1019	·0125	·134	·014
11	·09072	·01118	·120	·014
12	·0808	·00992	·109	·011
13	·07195	·00885	·095	·014
14	·06408	·00787	·083	·012
15	·05706	·00702	·072	·011
16	·05082	·00624	·065	·007
17	·04525	·00557	·058	·007
18	·0403	·00495	·049	·009
19	·03589	·00441	·042	·007
20	·03196	·00393	·035	·007
21	·02846	·0035	·032	·003
22	·02535	·00311	·028	·004
23	·02257	·00278	·025	·003
24	·0201	·00247	·022	·003
25	·0179	·0022	·020	·002
26	·01594	·00196	·018	·002
27	·0142	·00174	·016	·002
28	·01264	·00156	·014	·002
29	·01129	·00135	·013	·001
30	·01002	·00127	·012	·001
31	·00892	·0011	·010	·002
32	·00795	·00097	·009	·001
33	·00708	·00087	·008	·001
34	·0063	·00078	·007	·001
35	·00561	·00069	·005	·002
36	·00500	·00061	·004	·001

NEW STANDARD WIRE GAUGE prepared by J. R. BROWN & SHARPE, and adopted by the Brass Manufacturers of the United States.



The want of uniformity in common Wire Gauges is well known, but if they all agreed with the published tables of sizes, there would still exist serious objections to their use, as the variation between different

numbers is so irregular. This will be more clearly seen by reference to the diagram.

The two lines A C and B C meeting at C, represent the opening of an angular gauge. The divisions on the line A C, show the size of wire by the common gauge, those on the line B C by the new standard.

Wire to be measured by such a gauge, is passed into the angular opening till it touches on both sides, the division at the point of contact indicating the number. Thus, No. 15 old gauge would be No. 13 by the new. The angular principle is used in the above cut, as it shows the difference between the old and new standard to the best advantage; it is proposed, however, to make gauges of different forms, but all to correspond with the sizes of the new standard.

The divisions on the line A C, it will be observed, are very irregular, while those on B C increase by a regular Geometrical Progression. This principle is thought by many who are conversant with the subject, to be the true one for the construction of a gauge, and when generally adopted by the manufacturers in this country, an effort will be made to introduce it in England.

The foregoing tables show the actual dimensions of the old and new standards in decimal parts of an inch, U. S. Standard Measure, and also the difference between consecutive sizes of each gauge."

It is stated that favorable action was taken upon the propriety of adopting the new gauge and the following preamble and resolution adopted by fourteen companies located in New York and New England States engaged in the manufacture of brass plate and wire:

"Whereas, it seems desirable that some steps be taken to arrive at a more complete uniformity in the wire gauge used by the brass makers, and, whereas, J. R. Brown & Sharpe, of Providence, R. I., have prepared, at considerable expense, a gauge with a new grade of sizes, a plan which is by us approved; therefore,

"*Resolved*, That we will adopt said gauge, and be governed by it in rolling our metals, and will use our exertions to have it come into general use as the standard U. S. gauge."

It is very desirable that some standard should be adopted, and adhered to, so that manufacturers and purchasers would mutually understand each other in making contracts for boilers; and, as Brown & Sharpe's gauge has been partially adopted, no reason appears why it should not be entirely so.

If the boiler plate makers have taken any action upon the matter, or will take action upon it, an account of their proceedings made public through the *Journal* will be acceptable. J.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, May 17, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

A letter was read from Thomas Oldham, Esq., Superintendent of

the Geological Survey of India and of the Geological Museum, Calcutta, India.

Donations to the Library were received from the Royal Geographical Society and the Statistical Society, London; the Governor-General of India, Calcutta, India; the Smithsonian Institution, Washington, D. C.; the Rensselaer Polytechnic Institute, Troy, New York; and from Messrs. Jones & White, John E. Wootten, Prof. John F. Frazer, Prof. B. H. Rand, and the Board of Trade, Philadelphia.

Donations to the Cabinet from Mr. Joseph Kaye, of Pittsburgh, Pa.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of April.

The Board of Managers and Standing Committees reported their minutes.

Ten resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (4) were proposed, and the candidates proposed at the last meeting (9) duly elected.

Mr. Wood exhibited some specimens of wood, embossed by his patent process. The wood is soaked in water, and then subjected to pressure under a metal matrix heated sufficiently to burn away the superfluous material. The wood is not finished at one operation, the matrix being removed several times in order to brush off the charred wood. The specimens possess more softness than is usual in wood carvings; and when varnished have a beautiful appearance. The design is first modeled in clay or wax and a plaster cast taken from it; this serves as a pattern from which the matrix is moulded. The saturation by water prevents the burning or charring of the material not immediately in contact with the metal.

Mr. John E. Wootten exhibited and explained a working model of P. C. Clark's Patent Reciprocating Propeller. Two engines rotate a shaft, having at each end cranks to which are connected the upper ends of bars whose lower ends are paddles; the bars are connected to the boat by a vibrating link, which permits the points of attachment to the bar to have vertical but not horizontal motion; thus, the paddles describe an ellipse. A sliding-box at the upper end permits the bars to be moved so as to give more or less dip to the paddles, as may be required to suit the draft of the boat. This plan has been submitted to the Committee on Science and Art whose report may be published in this *Journal.*

Mr. Joseph Kaye presented a piece of the metal from the sinking head of the Floyd gun lately cast and bored at Pittsburgh, by Knapp, Rudd & Co. Mr. H. Howson and Mr. D. S. Williamson gave this description. The gun was cast upon a core through which a stream of cold water was constantly passing, the object being to produce metal of a uniform texture from the equal cooling and contraction of the mass. This plan has been patented by Lieut. Rodman. To exemplify the advantage of this mode of casting and cooling, a specimen of cast

iron cut from a shaft was placed on the table. In the middle of the piece, where the iron had retained its heat and softness for the longest time, the contraction of the surrounding parts caused the metal to assume an open, loose character, whilst the central portion was thrown into groups of spiny formation resembling frost-work. The bore of the gun is 15 inches; length 16 feet; total weight 24½ tons; weight of ball 420 lbs.

Mr. R. P. Morgan explained a working model of a wagon intended either for rail or for common roads, in which the usual flat tyer wheels were caused to track upon rails by the guidance of supplementary wheels which are lowered by mechanism and supply the place of flanches. An ingenious arrangement of links causes each set of supplementary wheels to retain their parallelism with their principal wheels when the curves are being passed. The plan is submitted to the Committee on Science and Art.

A hose coupling designed by Mr. Joseph Singer was laid upon the table for inspection. It is simple in construction and instantaneous in in its operation, by the movement of a jointed lever, whose forked ends abut upon the joined coupling at opposite points, whilst its two pivots are held by lugs attached to the coupling in such a way that adjustment may be obtained. A ring of leather forms the water-joint. This plan has been submitted to the Committee on Science and Art.

BIBLIOGRAPHICAL NOTICE.

The Dental Cosmos: A Monthly Record of Dental Science. Edited by J. D. White, M. D., D. D. S., J. H. McQuillen, D. D. S., and George J. Ziegler, M. D.: Philada., Jones & White, Publishers.

This spirited Monthly is an improved continuation of a well-established and long-known Quarterly, *The Dental News Letter*, under a new name more in accordance with the aims and objects of its publishers and editors, viz: "to present its readers with a faithful exhibit of the dental world."

The Dental News Letter was established in 1847 under the editorial supervision of Dr. J. R. McCurdy, who alone conducted it for the first six years of its existence whilst, for the remaining six years, his labors and responsibilities were shared by Dr. J. D. White, one of the editors of the present Journal, and its value was much enhanced during the latter part of this time by the addition of a Periscopic department managed by Dr. S. S. White. Doubtless, this issue has had much to do in cementing the scientific bonds of the dental profession, in this State and elsewhere, by affording a special medium for the communication of important practical results, and by stimulating that generous individual rivalry which elevates the profession as a mass, while it benefits the public in the same proportion.

The establishment and successful operation of highly scientific dental schools and honest, open, and fearless journals in several of our principal cities, has vastly benefited the profession in question by adding to its ranks well-trained and reliable practitioners, who are not only skilful operators, but acute observers and communicators of their observations for the benefit of others. The seven thousand dentists of this country are now no longer isolated practitioners, working each in his limited circle and knowing no interest beyond, but they are fast acquiring an "*esprit de corps*," which demands a revised literature and an advancing standard. It appears to us, therefore, that *The Dental Cosmos* is a step in the right direction—it is forwards. Its monthly issue is in accordance with the tendency of the age to the rapid accumulation and diffusion of knowledge.

The plan of the work seems excellent. The first portion is devoted to *Original Communications*, such as reports of cases, new views and practical hints from various practitioners. Attention to this department is earnestly pressed upon those anxious to enrich the science and the art. It is under the charge of the experienced journalist, Dr. J. D. White.

The second part comprises a *Review of Dental Literature and Art*, in which we find translations, condensations of choice matter from foreign and home dental journals, with judicious criticisms, &c. This is conducted by Dr. J. H. McQuillen, who has proved himself fully equal to the task.

The third part presents a *Periscope of Medical and General Science in their relations to Dentistry*. In this will be found many important facts and observations bearing upon dental subjects, judiciously culled from general and special fields of science, which would in all probability otherwise never reach the eye of the great majority of practitioners, together with such comments as appear applicable to the occasion. Dr. G. J. Ziegler, a well-known physician and writer, is entrusted with the care of this department.

In addition, we find Proceedings of various Dental Societies, Correspondence, and Editorials. It appears also to be an object of the editors, to have translated, and to reproduce at an early date, the various foreign prize essays and monographs of interest; for we have already perceived appearing in their pages in appropriate parts, FORGET'S *Memoir* (crowned by the Academy of Sciences, Paris, at its meeting of March 14, 1859,) *on Dental Anomalies and their influence upon the production of Diseases of the Maxillary Bones*. This is profusely illustrated, and has since been issued in pamphlet form.

Ten numbers of the *Cosmos* have been already placed before the public, and we are pleased to state that the anticipations in which we indulged of its extended usefulness and high professional tone, have been fully realized. G.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.,

Professor of Civil Engineering in the Philadelphia High School.

APRIL.—The changes of temperature in the course of the day, and in comparing one day with another, were greater during last April than in any other April for the last nine years. The average daily oscillation of the temperature was 18·9°, the nearest approach to it being in April, 1853, when it was 18·6°. The mean daily range of the thermometer was 7·4°; the highest previously during the month for the last nine years, was in 1854, when it was 7·2°.

The average temperature of the month was a little more than one degree below the average for the last nine years; but this difference was principally in the morning and evening, it being 1⅝° below in the morning and about 1½° in the evening, while at 2 P. M. the difference was less than 1°.

The warmest day of the month was the 21st, of which the average temperature was 62·7°. The thermometer was highest, reaching 81° about 3 P. M., of the same day. The thermometer was lowest on the morning of the 3d, but the 2d was the coldest day, showing a mean temperature of 35·7°. The temperature fell below the freezing point on two days of the month, the 2d and the 13th.

Rain fell on fifteen days, but the total amount (3·646 inches) was less than usual for April, and two inches less than in April of last year.

The first thunder and lightning observed this year occurred on Sunday, the 8th of the month.

On the evening of Friday, the 13th, an aurora was observed, extending above the northern horizon, in the shape of a bank of white or light blueish light, being in the highest part directly under the North Star, about 20° high.

On the afternoon of Saturday, the 21st, the temperature reached 81° between 3 and 4 P. M., the wind blowing from the west. At 4½ P. M., the wind changed suddenly to the E. N. E., and increased to a gale which continued till night. In less than half an hour the temperature fell fifteen degrees, and in four hours fifteen degrees more; that is, from 81° at 4 P. M., to 51° at 9 P. M. The barometer had been falling from the 19th of the month, when it read 30·3 inches, until after 2 P. M. on the 21st, just before the gale, when it read 29·544 inches, and began immediately to rise, and continued rising, but very slowly, for two or three days.

On the afternoon and evening of the 25th, a few flakes of snow fell.

There was but one day of the month entirely clear, and five days on which the sky was completely covered with clouds, at the hours of observation.

The barometer was lowest (29·319 inches) on the 1st of the month, and highest (30·303 inches) on the 18th. It is a remarkable fact in

connexion with the barometrical observations, that the average height of the barometer at 9 P. M. is very nearly the average of all the observations for the month, taken at 7 A. M., 2 P. M., and 9 P. M. It will be seen by an inspection of the comparison of results at the end of this article, that the means for 9 P. M. are but ·005 of an inch below the monthly means for nine years.

All barometrical observations, in order that they may be compared with each other, require to be reduced to the same degree of temperature. The column of mercury in the barometer tube is balanced by a column of air of the diameter of the tube, and extending from the instrument to the top of the atmosphere. Any general disturbance caused by the heating of the atmosphere, the influence of storms, or any alteration of the quantity of air over the position of the barometer, will cause a change in its weight, and consequently, to a slight degree, a change in the height of the column of mercury. In this way, a change in the temperature of the room in which the barometer is kept, changes the height of the mercurial column; and, therefore, though the pressure of the atmosphere may remain the same, the indications of the barometer will vary with the temperature. Hence arises the necessity of the reduction of the observations, by means of the attached thermometer, to the density of mercury at some fixed temperature. That of the freezing point of water has generally been adopted.

The reduction to the freezing point may be calculated by the formula,

$$\frac{m(t-32)-l(t-62)}{1+m(t-32)} \cdot b,$$

62° being the normal temperature of the standard of length, and 32° the freezing point of Fahrenheit's thermometer, m represents the decimal ·0001001, the expansion in volume of mercury for 1° F., t the observed temperature of the attached thermometer, l the decimal ·000003, the linear expansion of wood for 1° F., and b the observed height of the barometer. The linear expansion of wood is given in this place because the barometers generally used by the observers for the Franklin Institute are of that material, having a short brass scale fixed upon the wooden frame of the instrument. If barometers with brass scales extending from the cistern to the top of the mercurial column are used, then l, representing the linear expansion of brass for 1° F., will be 0·0000104344. By means of this formula, the following table of corrections for common wooden barometers has been calculated.

The sign + indicates that the correction to which it is prefixed should be added to the observed height of the mercurial column, and the sign — that the correction should be subtracted. Thus, if the observed height of the barometer is 30·23 inches, and the attached thermometer 75° F.; in the column of 30·0 inches go down as far as the horizontal line corresponding with 75° in the first vertical column which contains the degrees. The correction is seen to be —·127. We have thus,

	Barometer, observed height, . . .	30·23
	Correction for 75°, . . .	—·127
	Barometer at 32°, . .	30·103.
Again.	Barometer, observed height, . .	29·37
	Attached thermometer 25°, correction, .	+·018
	Barometer at 32°, . .	29·388.

Thus the reduction of the barometrical observations to the freezing point may be made for any height from 27½ up to 31 inches, and from 20° to 90°. The correction for the degrees between those given in the table, may readily be supplied by interpolation.

Correction to be applied to the observations of common wooden barometers to reduce them to the freezing point.

Attached Thermom.	Inches.							
	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0
20°	+·030	+·030	+·031	+·031	+·032	+·032	+.033	+·033
25	+·016	+·017	+·017	+·017	+·018	+·018	+·018	+·019
30	+·003	+·003	+·003	+·003	+·003	+·003	+·003	+·003
31	·000	·000	·000	·000	·000	·000	·000	·000
35	—·011	—·011	—·011	—·011	—·011	—·012	—·012	—·012
40	—·024	—·024	—·025	—·025	—·026	—·026	—·026	—·027
45	—·037	—·038	—·038	—·039	—·040	—·040	—·041	—·042
50	—·050	—·051	—·052	—·053	—·054	—·055	—·056	—·057
55	—·064	—·065	—·066	—·067	—·068	—·070	—·071	—·072
60	—·077	—·078	—·080	—·081	—·083	—·084	—·085	—·087
65	—·091	—·092	—·094	—·095	—·097	—·099	—·100	—·102
70	—·104	—·106	—·107	—·109	—·111	—·113	—·115	—·117
75	—·117	—·119	—·121	—·123	—.125	—·127	—·130	—·132
80	—·130	—·133	—·135	—·137	—·139	—·142	—·144	—·147
85	—·143	—·146	—·148	—·151	—·154	—·156	—·159	—·162
90	—·157	—·159	—·162	—·165	—·168	—.171	—·174	—·176

A Comparison of some of the Meteorological Phenomena of April, 1860, *with those of April,* 1859, *and of the same month for nine years, at Philadelphia.*

	April, 1860.	April, 1859.	April, 9 years.
Thermometer.—Highest, . .	81°	78°	87°
" Lowest, . .	29	31	20
" Daily oscillation,	18·90	15·50	16·50
" Mean daily range,	7·40	6·30	6·50
" Means at 7 A. M.,	43·96	45·70	45·58
" " 2 P. M.,	56·56	56·13	57·43
" " 9 P. M.,	47·92	49·01	49·39
" " for the month,	49·48	50·28	50·80
Barometer.—Highest, . .	30·303 in.	30·083	30·518
" Lowest, ...	29·319	28·890	28·884
" Mean daily range, .	·166	·160	·179
" Means at 7 A. M., .	29·849	29·723	29·800
" " 2 P. M., .	29·794	29·678	29·758
" " 9 P. M., .	29·830	29·703	29·787
" " for the month,	29·824	29·701	29·782
Rain and melted snow,	3·646 in.	5·668	4·965
Prevailing winds,	N. 89° W. ·250.	N. 69° W. ·224.	N. 70° W. ·179.

Abstract of Meteorological Observations for March, 1860; made in Philadelphia, Franklin, Indiana, and Allegheny Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.			TARENTUM. Allegheny Co. 40° 37′ N. 79° 46′ W. Height, 905 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain and Snow.	Prevail'g winds.	Thermom.		Prevail'g winds.	Thermometer.		Prevailing winds.
Mar.	Mean.	Mean daily range	Mean.	Daily oscillation	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.		Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·761	·347	57·8	10	7·5	·497	91	0·284	S W.	29·249	55·3	4·7	·327	57	1·000	W.	48·3	5·7	S E.	48·3	4·7	S W.
2	29·962	·221	56·0	21	5·5	·240	86		W.	29·521	52·7	4·0	·285	48		W.	54·3	6·0	(var.)	46·0	7·7	S W.
3	29·943	·168	51·7	19	4·3	·224	43	0·040	S E.	29·345	49·3	6·0	·308	79	0·090	W.	48·7	5·7	(var.)	44·0	4·7	S W.
4	29·819	·198	50·5	12	4·2	·094	21		WNW	29·317	47·7	5·0	·232	60		W.	42·3	7·7	S W.	42·3	2·3	S W.
5	29·758	·160	52·5	27	8·3	·400	67		S W.	29·172	52·0	11·7	·220	88		W.	44·7	9·7	S W.	47·0	10·0	S W.
6	29·799	·188	53·5	20	5·7	·170	28		(var.)	29·214	56·7	5·0	·316	50		W.	54·0	9·3	S W.	55·3	8·3	S W.
○ 7	29·724	·099	44·7	7	8·8	·284	88	0·176	S E.	29·111	50·0	10·7	·308	79		E.	59·3	5·3	S W.	58·7	7·3	S W.
8	29·682	·042	43·7	8	3·7	·264	92	0·368	E.	29·123	48·7	2·0	·334	56	0·469	W.	47·3	12·3	N.	47·3	11·8	(var.)
9	29·578	·104	38·3	18	6·0	·157	52	0·194	N W.	29·056	35·3	15·3	·144	63		W.	29·7	17·3	N W.	31·7	15·7	(var.)
10	29·702	·124	30·8	9	7·5	·156	84		N W.	29·183	30·7	4·7	·090	50		W.	21·0	5·7	N W.	26·7	5·7	N W.
11	29·814	·112	37·5	14	6·7	·102	40		WNW	29·271	38·0	7·0	·173	60		W.	33·7	12·7	S W.	38·0	8·0	S W.
12	29·599	·215	40·5	17	5·0	·234	70	0·195	(var.)	29·094	36·3	6·3	·139	56		W.	28·0	12·3	N W.	30·3	13·7	N W.
13	29·772	·173	38·7	11	6·8	·067	87		N W.	29·378	30·0	8·3	·062	20		W.	20·3	7·7	N W.	26·0	8·3	(var.)
☾ 14	29·816	·056	38·5	24	7·2	·103	80		N W.	29·370	38·3	8·3	·112	34		W.	32·7	12·3	N.	32·0	6·0	N W.
15	30·061	·266	43·7	25	5·2	·115	26		(var.)	29·581	42·7	4·3	·133	32		W.	36·0	3·3	N.	36·7	4·7	N E.
16	30·185	·104	45·7	26	2·7	·185	37		(var.)	29·662	43·8	2·0	·206	40		W.	43·7	7·7	E.	43·7	7·0	S W.
17	30·176	·011	48·8	22	4·2	·258	54		N E.	29·631	47·7	4·3	·268	58		E.	51·0	7·3	E S E.	45·3	3·0	?
18	30·136	·039	49·8	21	1·0	·231	45		N E.	29·602	57·3	6·7	·179	55		E.	50·7	4·3	S E	49·0	6·3	S E.
19	29·909	·227	47·7	16	4·2	·306	73	0·066	N E.	29·347	50·7	3·3	·321	80	0·531	E.	50·3	5·7	S E.	49·3	7·7	?
20	29·698	·216	46·0	19	3·0	·112	81		N W.	29·176	43·7	7·0	·143	43		W.	36·7	13·7	N W.	39·0	10·3	S W.
21	29·729	·061	35·5	12	10·5	·108	45		WNW	29·273	35·3	8.3	·017	61		W.	27·7	9·0	N W.	31·3	7·7	N W.
● 22	29·688	·091	36·0	19	5·5	·069	23		(var.)	29·133	39·0	4·3	·074	34		W.	30·0	6·3	N W.	33·7	3·7	(var.)
23	29·597	·047	43·3	29	7·3	·108	28		W.	29·038	50·3	11·3	·153	32		W.	41·7	11·7	S W.	43·3	9·7	W.
24	29·543	·105	40·3	15	7·0	·166	53		W.	28·979	38·3	14·3	·092	34		W.	29·3	11·0	N W.	32·3	11·0	W.
25	29·681	·138	35·8	11	4·5	·090	37		W.	29·101	34·0	4·3	·098	46		W.	29·7	2·7	N W.	28·0	4·3	N W.
26	29·820	·138	38·0	13	3·5	·118	42		W.	29·346	35·3	4·0	.113	42		W.	26·0	2·0	N W.	30·3	2·3	W.
27	29·908	·088	39·2	20	2·2	·072	21		W.	29·424	37·7	2·8	·125	40		W.	28·7	8·0	(var.)	32·0	5·0	N W.
28	29·717	·190	45·0	24	5·8	·091	21		S W.	29·163	43·3	7·7	·099	22		W.	33·3	6·0	S W.	37·0	6·3	N W.
29	29·691	·043	47·8	26	2·8	·109	22		S W.	29·145	47·7	5·0	·100	18		W.	39·0	6·3	S W.			S W.
☽ 30	29·733	·041	55·5	33	7·7	·156	21		S W.	29·219	54·7	7·0	·150	20		W.	45·3	6·3	S W.			W.
31	29·615	·118	58·8	26	3·3	·122	16		S W.	29·082	58·3	3·7	·240	20		(var.)	53·7	8·3	S W.	56·7		W.
Means	29·794	·133	44·7	18	5·4	·175	44	1·323	N79°W.	29·272	44·7	6·8	·179	46	2·090	S88°W.	39·2	5·6	N84°W.	40·0	7.2	West.

Abstract of Meteorological Observations for March, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Height 624 ft. Prof. M. JACOBS, Obs.					HARRISBURG, Dauphin Co. 40°16′, N. 76°50′, W. Ht., 300 ft. JOHN HEISELY, M.D., Obs.					SHAMOKIN, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRIEZ, Obs.				FLEMING, Centre Co. 40° 56′ N. 77° 53′ W. Height, 780 feet. S. BRUGGER, Obs.				SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2196 feet. GEO. MOWRY, Observer.						
Mar.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Barom. Mean.	Thermom. Mean	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean.	Thermom. Mean daily range.	Rain and Snow.	Prevail'g winds.	Thermom. Mean	Thermom. Mean daily range.	Rain and Snow.	Prevailing winds.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P. M.	Rain and Snow.	S W.
	Inch.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	Inch	°	°	Inch.	Per ct.	Inch.	
1	29·394	56·0	5·7	0·420	(var.)	29·639	55·3	5·8	0·951	W.	56·0	6·0	1·002	(var.)	50·7	0·6	0·350	N W	27·598	48 3	2·0	·270	72		
2	29·652	51·7	6·8		(var.)	29·896	54·0	2·7		W.	51·0	7·0		W.	48·0	4·0		N W.	27·620	45·3	6·0	·351	70		
3	29·436	49·8	6·0	0·010	S W.	29·770	49·7	4·3	0·069	E.	41·3	9·7	0·300	W.	44·3	11·7	0·162	(var.)	27 632	46·3	7·0	·335	93	0·281	
4	29·454	47·0	4·7		N W.	29·705	48·3	4·0		W.	45 7	4·3		W.	42·7	7·7		N W.	27·485	40·0	6·3	·133	41		
5	29·344	49·7	10·0		S W.	29·589	52·7	9·7		S W.	47·0	14·0		W.	49·0	15·7		N W.	27 509	47·0	9·0	·295	59	0·075	
6	29·364	55·0	5·3		S W.	29·649	56·7	5 3		(var.)	52·7	9·7		W.	56·3	9·3		S E	27·528	55·0	6·0	·419	68		
○ 7	29·272	49·3	6·8	0·060	S E.	29·573	46·7	10·0		N E.	43·0	9·7	0·331	E.	48·0	8·3	0·700	(var.)	27 421	59·3	4·3	·387	67		
8	29·209	45·7	3·7	0·200	(var.)	29·561	48·3	1·7		N E.	42·3	6·0	0·200	W.	47·7	3·7		(var.)	27·470	48·0	11·3	·205	40	0·094	
9	29·198	32·7	13·0	0·060	N W.	29·469	37·7	10·7	0·452	N W.	34·3	8·0	0·240	W.	32·3	15·3		W	27·382	28 3	19·7	·155	79		
10	29·342	27·7	6·0		N W.	29 586	32·3	5·3		W.	26·7	7·7	0·021	W.	26·0	7·0		N W.	27·490	21·0	7·3	·123	100	0·227	
11	29·479	36·0	8·3		(var.)	29·693	40·3	8·0		N W.	36·7	10·0		W.	33·7	8·0		N W.	27 583	32·7	11·7	·165	72		
12	29·242	37·7	5·7		N W.	29·496	39·7	5·8		N W.	37·3	6·0		W.	32·0	5·7	0·280	(var.)	27 394	27·0	9·7	·153	68		
13	29·513	29·7	8·0		N W.	29·762	32·0	8·3		N.	27·7	9·7		(var.)	24·7	8·7		N W.	27 691	21·7	8·7	·128	87		
☾ 14	29·486	36·3	6·7		N W.	29·767	39·7	7 7		N W.	32·7	5·0		W.	32·7	8·0		(var.)	27·692	30·7	9·0	·172	60		
15	29·734	37·7	1·8		N W.	29·909	44·7	5·0		N.	40·7	8·7		W.	37 3	4·7		E.	27·811	36·0	5·3	·159	41		
16	29·836	39·3	2·0		S.	30·117	44·7	0·7		S E.	40·3	1·0		W.	38·7	1·3		E.	27·856	40·0	4·0	·230	56		
17	29·807	44·0	4·3		(var.)	30·081	46·7	4·0		S E.	40·3	8·0		W	42·0	3·3		W.	27·854	43·3	3·3	·241	46		
18	29·739	49·7	5 7		N E.	30·025	53·0	4·3		S E.	46·0	4·3		E.	47·7	5·7		(var.)	27 527	48·0	10·0	·296	79		
19	29·628	44·7	6·0	0·680	N E.	29·790	49·7	6·0	0·560	N E.	47·7	7·7	0·280	E.	49·3	10·3	0·440	(var.)	27·633	46·3	1·7	·329	86	0·296	
20	29·313	42·0	2·7		N W.	29·582	47·0	2 7		(var.)	43·7	4·0		W.	43·3	6·0		N W.	27 508	37·7	8·7	·150	52	0·246	
21	29·377	34·7	7·8		N W.	29·627	39·7	7·8		N W.	31·7	8·7		W.	32·0	11·3		N W.	27 630	27·7	10·0	·142	69		
● 22	29·268	36·7	4·7		N W.	29·497	41·3	5·0		N W.	34·3	4·7		W.	36·0	6·0		W.	27·554	30·7	6·7	·130	55		
23	29 201	46·7	10·0		W.	29 436	45·3	7·0		W.	42·0	7·7		W.	42·0	6·0		W.	27·339	45·0	14·3	·364	76		
24	29·184	32·7	14·0		N W.	29·855	40·3	8·0		W.	32·7	9·3		W.	32·3	9·7		N W.	27 290	29·7	15·3	·168	79	0·109	
25	29·327	30·3	2·3	0·037	N W.					W.	30·7	3·3		W.	28·7	3 7		W.	27·438	28·0	8·7	·147	84		
26	29·500	33·2	2·8		W.	29·754	37·8			N W	32·0	1·3		W.	29·3	0·7		N W.	27·606	27·0	1·7	·142	69		
27	29·620	37·0	3·6		N W.	29·825	39·8	4·9		S W.	34·3	8·3	0·050	W.	32·0	5·3		N W.	27·678	29·0	6·0	·100	64		
28	29·322	41·0	5·0		W.	29·566	45·0	5·7		(var.)	37·7	8·0		W.	36·7	6 7		W.	27·494	35·3	7 7	·212	63		
29	29·310	44·7	3·7		S W.	29·536	46·7	3·7		(var.)	38·0	4·7		W.	40·3	4·3		W.	27 450	41·0	7·7	·207	53		
☽ 30	29·380	55·8	10·7		(var.)	29·683	55·0	6·8		S W	46·7	10·0		(var.)	46·0	8·7		S E.	27·523	50·0	9·0	·268	60		
31	29·170	56·7	6·7		S W.	29·432	60·7	5·7		S W.	54·7	8 7		W.	52·0	16·0		W.	27·393	56·7	6·7	·305	43		
Means	29·416	42·3	6·0	1·407	N60°W.	29·679	45·9	6·6	2·062	N60°W.	40·4	7·0	2·384	S85°W.	40·2	7·1	1·932	N57°W.	27·574	39·0	7·6	·223	66	1·568	S82°W.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JANUARY 1, TO MARCH 31, 1860.

It will be seen by the readers of our Journal, that the Committee of Publication have determined upon a change and curtailment in the mode in which the list of American Patents has hitherto been kept by us. The copy of the claim will be hereafter omitted in this Journal, and the list confined to the register of the names and residence of the patentee, the date and subject of his patent.

While our Journal was the only means by which a list of Patents reached the American reader, the evident usefulness of the list determined the Committee to continue it, notwithstanding its expensiveness and the rapidly increasing space which it occupied in our pages, to the exclusion of matter, in a general point of view, more interesting and important.

But now, when this same list is published by other Journals, and especially when the *Scientific American*, issued weekly, furnishes its readers with its list necessarily ahead of ours, which can only be completed to the end of the preceding month; and when the Patent Office itself, by the yearly publication of the claims, in a convenient form, and with proper drawings, supersedes the necessity of our list as a permanent record; the Committee have thought that they would increase the interest and the usefulness of their *Journal* by restricting the list to an Index of Patents, which still gives the reader the most important information which he wants, and allows us to devote the pages which were before occupied by this, for the most part useless matter, to the report and discussion of subjects which may render them more useful and interesting to that class of readers for whose benefit it is intended.

We hope the change will meet the approbation of our subscribers, and in that hope, submit this explanation to them.

	January, 1860.			Date.
Alarm for Drawers,	Wm. B. Card,	Sag Harbor,	N. Y.	10
Anchor Shackle,	Thomas Leavitt,	Malden,	Mass.	3
——— Tripper,	H. Higgins,	Orleans,	"	10
Apples,—Grinding	J. T. Carpenter,	Martin's Ferry,	Ohio,	24
Axle Boxes for Railroad Cars,	Joseph Harris,	Dorchester,	Mass.	3
——— Vehicles,	J. Halloway,	City of	N. Y.	3
Balance,—Hydrostatic	Samuel Squire,	Brooklyn,	N. Y.	10
Bed Bottom,	J. T. Allen,	City of	"	24
— Bottoms,—Spring,	R. Halden,	"	"	3
— Canopy,	J. E. Palmer,	Montville,	Conn.	31
— Fastening,	Adolph Roda,	Rochester,	N. Y.	24
Bedstead,—Invalid	Samuel Gantz,	Beaver Creek,	Md.,	3
———Ventilating	H. W. Henly,	City of	N. Y.	24
Bee Hives,	John Meese, Sr.,	Milton,	Ohio,	31
Beer Measure,	Edward Bagot,	City of	N. Y.	10
Belt Punch,	C. D. Wheeler,	"	"	24
Belting,—India Rubber	D. C. Gately,	Newtown,	Conn.	3
———Rubber	"	"	"	31
———	T. J. Mayall,	Roxbury,	Mass.	31
Blowers,	T. C. Richards,	Milwaukee,	Wis.	17
Boats,—Construction of	Perry Davis,	Providence,	R. I.	3
Boiler Plates,—Riveting	J. B. Henry,	City of	N. Y.	17
Bonnet Fronts,—Formers for	George A. Cox,	Brooklyn,	"	17
Boot Heels,—Attaching, &c.,	H. Saloshinsky,	Boston,	Mass.	31
Boot and Shoe Soles,	J. B. Hayden,	Easton,	N. Y.	24
Boots and Shoes,—Heels for	P. Shaw,	Boston,	Mass.	3

Boots and Shoes,—Manufacture	F. D. Ballou, .	Abington,	Mass.	10
———— Pegging	W. N. Hawley, .	Hartford,	Conn.	31
Brakes for Railroad Cars,	M. Obermiller, .	Tiffin,	Ohio,	3
——— Self-acting Wagon	J. Dutcher, . .	Gibson,	Penna.	24
Brick Machines, .	Lewis Kirk, .	Reading,	"	31
—— Moulds, .	J. A. Hamer, .	"	"	3
Bridges,—Truss Frames for	Enoch Jacobs, .	Cincinnati,	Ohio,	3
Bridle Belts, .	W. F. M. Williams, .	Augusta,	Georgia	10
Brush Blocks,—Boring	T. Mitchell, .	Lansingburgh,	N. Y.	10
Bureau, . .	J. H. Beller, . .	City of	"	24
Bustle Hoops,—Clasps for	F. S. Otis, .	Brooklyn,	"	17
Buttons, .	G. A. Meacham, .	City of	"	10
Cabbage Cutter, .	J. C. Wilkins, .	Fox Chase,	Penna.	3
Cables,—Stopper for Chain	James Tucker, .	Washington.	D. C.	3
Callipers, .	C. D. Sutton, .	Kensico,	N. Y.	3
Candles,—Coating .	C. Morfit, . .	City of	"	10
——— Manufacture of	H. Halverson, .	Cambridge,	Mass.	10
——— Moulding .	G. A. Stanley, .	Cleveland,	Ohio,	10
————	"	"	"	10
Canes for Physicians, .	S. T. Trowbridge, .	Decatur,	Illinois,	3
Cant Hooks, .	P. Hinds, . .	Cedar Run,	Penna.	3
Car Couplings, .	Joel Hood, .	Milwaukee,	Wis.	31
Changing Motion, .	C.L.Pyron and R. Bruce,	Manchester,	Tenn.	3
Chain from Sheet Metal, .	L. Towne, . .	Providence,	R. I.	10
Churn, . .	J. P. Fitch, .	City of	N. Y.	17
——— .	D. C. Brown, . .	"	"	24
——— .	Lester Day, .	Buffalo,	"	31
Cider Mills, . .	R. M. Curtice, .	North Adams,	Mich.	10
Clap Boards, .	A. A. Wilder, .	Detroit,	"	10
Clevis,—Clamp for Making	V. M. Chaffee, .	Xenia,	Ohio,	31
Clocks, . .	E. M. and J. E. Mix,	Ithaca,	N. Y.	31
Clothes Dryer, .	B. B. Howse, .	Morrisville,	Vermt.	3
——— Frame, .	T. S. Scoville, .	City of	N. Y.	3
——— Wringer, .	Meldrum & Paxson,	Griffin's Mills,	"	24
Coal Excavators, .	H. Welverth, .	Caseyville,	Ky.	3
—— Screens, .	H. L. Cake, . .	Pottsville,	Penna.	24
—— Sifters, .	J. A. Howland, .	Providence,	R. I.	10
——— .	J. A. Sheffer, . .	Rochester,	N. Y.	10
Coffee Pots, .	W. Chesterman, .	Centralia,	Iowa,	24
——— .	G. R. Farrington, .	Xenia,	Ohio,	24
Corn Planters, .	A. Anable, .	Middlesex,	N. Y.	3
——— .	John Gross, . .	Decatur,	Illinois,	3
——— .	Daniel Nichols, .	Onargo,	"	3
——— .	Joseph J. Knight, .	Philadelphia,	Penna.	10
—— Shellers, .	S. Fletcher and J.P. Pike,	Bloomfield,	Maine,	3
Cotton Gin, .	B. Jenks and W.A.Tuttle,	Philadelphia,	Penna.	3
——— .	L. S. Chicester, .	City of	N. Y.	10
——— Goods,—Finishing	C. S. Davis, . .	Harrisburgh,	Penna.	24
——— Presses, .	J. T. Ham, .	Sinatobia,	Miss.	10
——— Screens for Cleaning	John E. Crane, .	Lowell,	Mass.	24
——— Stalks,—Pulling &Cut'g	Smith Beers, .	Naugatuck,	Conn.	17
Crutches, . .	Aug. Beckel, . .	Philadelphia,	Penna.	17
Cultivators, .	F. Davis, . .	Lima,	Ohio,	3
——— . .	H. R. Kinney, . .	Portsmouth,	"	3
——— .	F. and P. A. Misner,	Fox,	Illinois,	3
——— . .	J. K. Staman, .	Mifflin,	Ohio,	10
——— Cotton, .	T Newcomb & GW Byrd,	Smith's Fork,	Tenn.	3
Curtain Fixtures, .	A. C. Babcock, . .	New Haven,	Conn.	17
——— .	Wm. Rice, .	Philadelphia,	Penna.	24
——— .	C. Fisher, . .	Milton,	Mass.	31
Distilling Apparatus, .	James Sloan, .	Pittsburgh,	Penna.	17
Ditching Machines, .	F. B. Scott, . .	Buffalo,	N. Y.	24

Dove-tailing Machine, .	Thos. H. Burley, .	City of	N. Y.	3
Drain Tile Machine,	S M Smith & C Winegar,	Union Springs,	"	10
Draining and Pipe Laying,	Ira C. Pratt, . .	Morton,	Illinois,	3
Dresses,—Frames for Ladies'	J. R. Palmenburg,	City of	N. Y.	10
Egg-beater, .	S. Walker, . .	Boston,	Mass.	24
Evaporating,—Apparatus for	John Sutton, .	City of	N. Y.	3
Fan Blowers, .	H. B. Adams, .	City of	N. Y.	31
Fatty Matters from Residues,	D. Thain & W. Jackson,	Philadelphia,	Penna.	10
Faucets, .	A. S. Hart, .	Buffalo,	N. Y.	17
Felt Rubber Goods,—Finishing	J. T. Trotter, .	City of	"	3
Fertilizers, . .	L. Harper, . .	Riceville,	N. J.	31
Filters, . . .	C. F. Baxter, .	Boston,	Mass.	31
Fire Arms,—Breech-Loading	T. P. Gould, . .	Niagara Falls,	N. Y.	3
———— Magazine .	P. Boynton, .	Canton,	"	3
———— Projectiles for	Wm. Wheeler, . .	Philadelphia,	Penna.	24
———— Repeating .	WH Morris & C L Brown,	City of	N. Y.	24
Flour Mills, .	I. M. Clark, .	Philadelphia,	Penna.	10
Flower Pots, .	John Hively, . .	Dayton,	Ohio,	17
Fruit Gatherers, .	D. P. Chamberlain,	Hudson,	Mich.	3
Furnaces for Burning Bagasse,	S. H. Gilman, .	New Orleans,	Louis.	10
——— Hot Air	S. Wethered, . .	Baltimore,	Md.	3
——— .	R. B. Pullan, .	Cincinnati,	Ohio,	24
Gas,—Hydro-carbon	J. A. Bassett, . .	Salem,	Mass.	3
———— .	J. Calkins, .	Hudson,	N. Y.	3
Gas-lighting by Electricity,	W. W. Bachelder, .	City of	"	31
Gauges,—Pressure .	H. W. Farley, .	Hannibal,	Mo.	24
Glue Pot, . .	J. Turner, . .	Cambridgeport,	Mass.	24
Gold Separators, .	R. L. Reaney, .	Philadelphia,	Penna.	10
Grain Fans, .	G. Goewey, . .	"	"	10
—— Winnowers, .	H. H. Beach, .	"	"	10
Gums,—Treating Waste	J. Murphy, . .	City of	N. Y.	3
Gunpowder Mills, .	B. Potter, Jr., .	Hubbardston,	Mass.	24
Hair Brush Blocks,—Shaping	A. G. Mitchell, . .	Lansenburg,	N. Y.	31
Harrows, .	J. Russell, .	Grampian Hills,	Penna.	17
Harvesters, .	J. Scoville, . .	Buffalo,	N. Y.	31
Hat Blocks,—Turning	J. H. Masker, .	Newark,	N. J.	3
— Bodies,—Felting .	Blakslee & Middlebrook,	Newtown,	Conn.	10
————Forming,	S. Boyden, . .	Newark,	N. J.	10
Hay and Straw Cutters, .	S. S. Clark, .	Manchester,	N. H.	17
Heating & Ventilating Buildings	Lester & Hjortsberg,	Chicago,	Illinois,	3
Hoisting Apparatus, .	J. L. Pott, . .	Pottsville,	Penna.	24
Hominy Mills, .	J. Donaldson, .	Rockford,	Illinois,	24
Hop Frames, .	L. A. Beardsley, .	SouthEdmeston	N. Y.	10
Horse Collars, .	J. Bullock, .	Baltimore,	Md.	10
———— Stuffing	W. S. Habberton, .	Mount Carmel,	Illinois,	3
—— Powers, .	F. W. Robinson, .	Richmond,	Indiana,	10
—— Shoe, .	Joseph Carlin, . .	Cumminsville,	Ohio,	17
Hose Couplings, .	J. Singer, . .	Cleveland,	"	3
———— .	L. Button and R. Blake,	Waterford,	N. Y.	10
Hose Pipes,—Nozzles for	N. Hatz, .	Trenton,	N. J.	31
Hot Air Engine, .	B. F. Craig, . .	Washington,	D. C.	17
Hydrants, .	G. W. Robertson, .	Philadelphia,	Penna.	24
——— Waste Cocks	" " .	"	"	10
Ice Cream Freezers, .	E. P. Torrey, .	Jersey City,	N. J.	17
— Prevent Slipping on	H. S. Schell, .	Philadelphia,	Penna.	24
— Shavers, Cutters, &c.,	W. H. Hope, .	Washington,	D. C.	31
Inkstands, . .	J. R. Ender, .	Trenton,	Louis.	3
——— .	Howell Evans, .	Philadelphia,	Penna.	10
——— . .	T. P. Howe, .	City of	N. Y.	31
Iron Pins,—Making Coated	De G. and F. Fowler,	N. Bradford,	Conn.	17

Iron,—Smelting and Refining	R. G. Pomeroy,	City of	N. Y.	24
Ironing Tables,	G. F. Zimmerman,	Philadelphia,	Penna.	3
Jewelry,	J. J. Huber,	Geneva,	Switzerl'd	3
Journal Boxes,	J. Bryant,	Brooklyn,	N. Y.	3
Lamp-lighting Device,	G. R. Proctor,	Beverly,	Mass.	24
—— Self-lighting	T. W. Carroll,	Baltimore,	Md.	24
Lamps,	T. Houghton,	Philadelphia,	Penna.	10
——	J. K. Leedy,	Woodstock,	Va.	24
——	G. Neilson,	Boston,	Mass.	24
—— Burners for Vapor	T. Connelly,	Philadelphia,	Penna.	24
——	A. Geiger,	Dayton,	Ohio,	31
Lard Expresser,	C. Bixler,	Rogersville,	"	24
Latch for Gates,	Eli Manross,	Bristol,	Conn.	10
—— Sliding Doors,	H. Belfield,	Philadelphia,	Penna.	10
Lathes,—Back Centres for	A. Lafever & G C Barnes,	Battle Creek,	Mich.	31
—— Rest for	W H Hendrick & J Jacobs,	Mount Vernon,	Ohio,	31
Leather,—Finishing	R. L. and C. Smith,	Stockport,	N. Y.	10
——Polishing	R. A. Stratton,	Philadelphia,	Penna.	24
——Splitting, &c.,	Jacob Edson,	Boston,	Mass.	31
Legs,—Artificial	D. D. Douglass,	Springfield,	Mass.	10
Levels,—Attaching Spirit	Joseph Steger,	Mattewan,	N. Y.	24
—— for Surveyors,	S. D. Hailey,	Jackson,	Tenn.	10
Life-Preserving Raft,	Albert Baker,	Appleton,	Wis.	17
Lock,	Leger Diss,	Oriskany,	N. Y.	3
Locks for Carpet Bags,	Z. Walsh,	Newark,	N. J.	24
—— for Hoops,	A. P. Merrill, Jr.,	Natchez,	Miss.	3
Locom. Eng. & Cars Combined,	M'Dowell & Wheeler,	City of	N. Y.	31
Locomotives on Ice,	N. Wiard,	Janesville,	Wis.	24
Lubricating Compound,	J. B. McMunn,	Port Jervis,	N. J.	3
Malt Liquors,—Preserving, &c.	M. Reeder,	Philadelphia,	Penna.	24
Marble,—Artificial	Richard Lamb,	City of	N. Y.	31
Match Safes,	Levi Burnell,	Milwaukee,	Wis.	3
—— Pocket	A. M. Smith,	City of	N. Y.	17
Mat for Tables,	Ira Leonard,	Lowell,	Mass.	24
Mattresses,—Shavings for	F. Skinner,	New Haven,	Conn.	10
Meat Cutter,	O. D. Woodruff,	Southington,	"	10
Medical Topical Applications,	G. E. B. French,	Washington,	D. C.	3
Medicated Pads,	W. D. Titus,	Brooklyn,	N. Y.	3
Metals,—Coloring Surface of	M. Edwards,	Cambridge,	Mass.	31
Milk Pan Rack,	G. B. Lewis,	MoreauStation,	N. Y.	3
Mill Spindles,	Samuel Hoyt,	Wilmington,	Del.	31
——Stones,—Dressing	J. Yarborough,	Milton,	N. Car.	24
—— Picking	E. W. Daniells,	Springfield,	Mass.	24
Mills,	F. B. Hunt,	Cincinnati,	Ohio,	10
—— Grinding	T. E. Hunt,	Louisville,	Ky.	3
Mining,—Hydraulic	M. A. Winham,	San Juan,	Cal.	3
Molasses Gate,	G. W. Hubbard,	Meriden,	Conn.	10
Moulded Articles,—Hollow	D. D. Parmelee,	Salem,	Mass.	17
Moulding,—Cutting	C. B. Rogers,	Norwich,	Conn.	10
Mortising Machine,	F. H. Harwood,	Rushville,	N. Y.	31
—— Tool,	T. Board and C A Austin,	Jackson,	Va.	10
Mosaics,—Wooden	L. D. Forrest,	Derby,	Conn.	24
Mowing Machine,	O. R Chaplin,	Waterford,	Vermt.	10
Newspapers,—Directing, &c.	Jesse Batty,	Honeoye Falls,	N. Y.	17
—— Printing Adresses	J. J. Campbell,	Georgetown,	C. W.	17
Nut Cracker,	L. A. Clark,	Bridgeport,	Conn.	24
Oil from Cotton Seed,	G. G. Henry,	Mobile,	Ala.	17
Oils,—Siccative	John Roux,	City of	N. Y.	24
Paddle Wheel,	E. Haight,	Buffalo,	N. Y.	31
Paints,—Mixing	Uri Lee,	Burlington,	Mich.	3

Pantaloons,	W. Franklin,	New Haven,	Conn.	17
Pastry Board,	L. E. Higby,	ShelburneFalls,	Mass.	31
Pen Rack,	James Young,	Boston,	"	3
Pessaries,—Elastic	J. A. Wadsworth,	Providence,	R. I.	24
Piano Forte Action,	Joseph Kohnle,	City of	N. Y.	24
Pictures on Glass,—Backing	Henry and C. A. Seely,	"	"	3
Pivot Bearing,	F. B. Lowthrop,	Trenton,	N. J.	3
Planing Machines,	S. S. Gray,	Boston,	Mass.	24
Ploughs,	H. T. Cromwell,	Cythiana,	Ky.	3
———	V. M. Chaffee,	Xenia,	Ill.	17
———	J. L. Dutton, Jr.,	Cherry Lake,	Fla.	31
———	J. V. Taylor,	Dixon,	Ill.	3
——— Mole of Drain	John Lane,	Lockport,	"	10
Power Looms,	W. H. Gray,	Dover,	N. H.	17
Preserve Can Covers,	C. L. Kelling,	Mechanicsburg,	Penna.	24
——— Stopper,	W. P. Patton,	Harrisburg,	"	10
Presses,	G. W. Peniston,	North Vernon,	Ind.	3
———	T. H. McCray,	Tellico,	Texas,	17
——— Cotton and Hay	N. Chapman,	Mystic River,	Conn.	10
——— Hay	W. McCord,	Sing Sing,	N. Y.	24
Printing Presses,	P. G. Gordon,	City of	"	10
———	V. M. Chaffee,	Xenia,	Ill.	17
———	O. E. Weston,	Roxbury,	Mass.	17
———	J. W. Latcher,	Northville,	N. Y.	31
——— Apron for	C. McBurney,	Roxbury,	Mass.	17
——— Feeding	R. Larter, Jr.,	Newark,	N. J.	10
Pulleys,—Facing	Theodore Blume,	Cincinnati,	Ohio,	10
——— Grooved	L. Planer,	City of	N. Y.	3
Pulmonometers,	A. Eckert,	Dayton,	Ohio,	10
Pumps,	Walter Peck,	Winnebago,	Ill.	3
Railroad Car Wheels,	W. Smith,	Pittsburgh,	Penna.	10
——— Cars,—City	W. C. Allison,	Philadelphia,	"	3
——— Iron	J. Miner and S. Merrick,	New Brighton,	"	10
——— Eng's for street	R. H. Long,	Philadelphia,	"	24
——— Seats, &c., for	T. T. Woodruff,	"	"	24
——— Springs for	D. Johnson,	Chicago,	Ill.	24
——— Switches,	A W Elliott & G S Conkling,	Goshen,	N. Y.	3
———	J. H. Shedd and W. Edson,	Boston,	Mass.	24
———	J. S. Sanson,	Philadelphia,	Penna.	31
——— Time Indicator,	T. Moffet,	Chicago,	Ill.	31
Rakes,—Horse	R Lounsbury & F G Wilson	Ontario,	N. Y.	31
Reaping and mowing,—combined	T. H. Dodge,	Washington,	D. C.	31
Refrigerators,	J V Adrance & J W Clark	Buffalo,	N. Y.	3
Retorts,—Coal	F. W. Willard,	City of	"	3
Road Scraper,	Nelson Peck,	Wilmington,	"	3
Roof Covering,—Portable	H. Tucker,	Cambridgeport,	Mass.	17
Rope,—Laying	G. W. Pitman,	Bushwick,	N. Y.	24
Rope Making,	C. R. Bellows,	Seneca Falls,	"	17
Rudders,—Attachment for	B. F. Delano,	Boston,	Mass.	31
Ruling Machines,	L. R. Dreysel,	St. Louis,	Mo.	3
Saccharine Juices,—Evaporating	J. Souther,	Boston,	Mass.	10
Sail Grommet,	W. W. Wilcox,	Middletown,	Conn.	31
Sails,—Attaching Bonnets to	Jon Smith,	Dorchester,	Mass.	24
——— Reefing Fore and Aft	J. W. Gill,	Exeter,	N. H.	10
———	W. Morton,	Friendship,	Maine,	17
———	S. G. Martin,	South Amboy,	N. J.	24
Sap Conductors,	Eli Mosher,	Flushing,	Mich.	17
Sash Supporters,	S. G. Crane,	Rochester,	N. Y.	17
Sawing Machine,	R. B. Brown,	Cambridge,	Vermt.	10
———	K. R. Olmstead,	Chicago,	Ill.	31
Saw Mill,	J. H. Jenkins,	Smithville,	Mo.	31

Saws,—Filing .	P. Crosby, .	City of .	N. Y.	17
———-Hanging Reciprocating	L. Anderson, .	Painesville,	Ohio,	17
Scabbards to Belts,—Attaching	W. Lewis, . .	Brooklyn,	N. Y.	24
Scaffolding, .	E. Duchamp, .	St.Martinsville,	La.	17
Seaming Machine,—Double	L. S. Hurlbert, .	Painesville,	Ohio,	3
Seat and Cane Combined,	J. K. Andrews, .	Antrim,	"	3
Seeding Machines, .	G. B. Markham, .	Mead's Mills,	Mich.	3
———— .	J. W. Hudson, .	Lafayette,	Ind.	10
Sewing Machines, .	Austin Leyden, .	Atlanta,	Georgia,	3
———— .	John Dick, .	City of	N. Y.	10
———— .	A. F. Johnson, .	Boston,	Mass.	24
Shade Fixture, .	V. Drew, .	City of	N. Y.	17
Shears, . .	Joseph Smith, .	Cincinnati,	Ohio,	24
——— Tinman's .	A. Worden, .	Ypsilanti,	Mich.	31
Ships,—Buoying .	T. C. McKeen, .	Nashville,	Tenn.	17
—— Tillers, .	J. T. Chalot, .	Buffalo,	N. Y.	3
Shirred Goods, .	H. H. Day, . .	City of	"	3
Shoe-laces,—Fastening for	L. J. Worden, .	Utica,	"	24
Shutter Fasteners, .	A. Ferber, . .	Elizabeth,	N. J.	31
Skates, . .	T. W. Brown, .	Boston,	Mass.	24
——— .	L. J. Wicks, . .	City of	N. Y.	31
——— Fastening .	H. Rasquin, .	"	"	10
Skirts,—Skeleton .	R. W. Hill, . .	Naugatuck,	Conn.	17
Slates for Schools, .	G. N. and G. Munger,	New Haven,	"	24
Soap, .	A. H. Platt, .	Cincinnati,	Ohio,	17
—— Composition for .	Edward Patrie, .	Livingston,	N. Y.	3
Spectacle Cases,—Catch for	G. N. Cummings, .	Meriden,	Conn.	24
Spinning Frame,—Cop .	George Bradley, .	Paterson,	N. J.	10
———— Ring	M. P. Wilmarth, .	Pawtucket,	R. I.	10
Springs for Carriages, &c.,	H. Gardiner, .	City of	N. Y.	3
———— .	J. M. Forrest, .	Norfolk,	Va.	31
———— Cars, .	Richard Vose, .	City of	N. Y.	3
——— Helical .	J. W. Peck, Jr., .	Brooklyn,	"	24
Spur,—Heel .	M. Young, Jr., .	Frederick,	Md.	31
Staves,—Dressing .	E. and B. Holmes,	Buffalo,	N. Y.	10
Steam Boilers, .	Septimus Norris, .	Philadelphia,	Penna.	3
———— .	W. Schaubel, .	"	"	10
———— Construction of	J. Montgomery, .	Baltimore,	Md.	10
———— Feed water app's.	J. Hibbard, .	Hermitage,	N. Y.	17
———— Remov'g Incrust'n	H. F. and L. F. Knoderert,	Chilicothe,	Ohio,	3
Steam,—Decomposing .	J. A. Bassett, .	Salem,	Mass.	31
Steam Engines, .	M.Cridge & S.Wadsworth	Pittsburgh,	Penna.	3
———— .	W. L. Gold, .	Allegheny,	"	3
———— Exhaust Pipe	G. Edwards, .	Worcester,	Mass.	31
———— Oscillating	W. S. Mackintosh,	Pittsburgh,	Penna.	17
————	" & J Hemphill,	"	"	17
———— Valve Gear for	Julius King, .	Hoboken,	N. J.	24
——— Gauges, .	C. W. Kimball, .	Springfield,	Mass.	17
———— .	E. G. Allen, .	Boston,	"	17
——— Generator, .	Wm. Rice, . .	Philadelphia,	Penna.	24
——— Superheating	S. N. Carvalho, .	Baltimore,	Md.	3
———— .	G. A. Stone, . .	Roxbury,	Mass.	31
——— Valves, .	M. Cridge, .	Pittsburgh,	Penna.	3
Steel,—Manufacture of .	B. Treuller, . .	Dale,	"	31
——— Tempering .	John Wright, .	Sheffield,	Eng.	3
Steering Apparatus, .	J. S. Colvin, . .	Pittsburgh,	Penna.	3
Stereoscopic Instrument,	W. Lloyd, .	City of	N. Y.	24
Stick,—Improved .	A. F. Johnson, .	Boston,	Mass.	24
Stone Dressing, .	G. J. Wardwell, .	Barnston,	Canada,	10
Stop Cock,—Operating .	D. N. Dunzack, .	Salem,	Mass.	31
Stove Registers, .	W. Race, .	Seneca Falls,	N. Y.	10
Stoves, . .	H. B. Fay, .	City of	"	10

Stoves, .	J. Van Wormer, .	Albany,	N. Y.	24
——— Cooking .	E. J. Cridge, . .	Troy,	"	24
Straw Cutters, .	N. Homes, .	Laona,	"	3
——— .	J. W. McGaffey, .	Buffalo,	"	31
Sugar Juices,—Evaporating	E. Duchamp, .	St.Martinsville,	La.	31
——— Pans,—Evaporators for	J. Larkin, . .	Thibodeux,	"	17
Table Leaf Support, .	Sylvanus Walker,	Boston,	Mass.	31
Tanning, .	R. B. Thompson, .	Galesburg,	Ill.	10
——— Skins and Hides,	W. D. Bunting, .	Cleveland,	Ohio,	31
Telegraph Cables,—Laying	W. H. Horstman, .	Brooklyn,	N. Y.	3
Telegraphs.—Electric .	George Doyle, .	Ottawa,	Ill.	31
Tenons,—Cutting Round	L. A. Dole, .	Salem,	Ohio,	10
Thermometers,—Air& Mercurial	J B Currier & A J Simpson	Lowell,	Mass.	31
Thills of Vehicles,—Attaching	A. Odell, .	City of	N. Y.	17
———	A. J. Ritter, . .	Rahway,	N. J.	24
Thread,—Spooling .	C. M. Spencer, .	Manchester,	Conn.	31
Tinware,—Manufacture of	A. J. Olmsted, .	Binghampton,	N. Y.	17
Trap for Animals, .	R. P. Buttles, .	Mansfield,	Penna.	4
——— .	J. P. Wilson, .	Frankfort,	N. Y.	31
———Rats, .	Andrew Hunter, .	Heresford,	Va.	24
——— Steam .	Allen Lapham, .	Brooklyn,	N. Y.	24
Tunnels,—Tubular Submarine	Arthur Folsum, .	Boston,	Mass.	3
Valves,—Balanced Slide .	John Sloan, .	Pittsburgh,	Penna.	31
Vapor for Medical Purposes,	J. Gardette & H. Rance,	New Orleans,	La.	3
Vegetable Cutter, .	F. Schutte, .	Philadelphia,	Penna.	3
——— .	J. W. Stickler, .	Orange,	N. J.	3
Ventilating Sinks,Water Closets,	W. G. Mackey, .	City of	N. Y.	10
Ventilation of Bulk Windows,	S. R. Mason, .	Philadelphia,	Penna.	24
Ventilators, ———	G. Colhoun, .	"	"	31
Washing Machine, .	J. S. Gray, .	Hartford,	Conn.	3
——— .	A. & D. Schultz, .	Reading,	Penna.	10
——— .	James M. Kern, .	Morgantown,	Va.	31
Watch key & calender combined,	H. C. Foote, .	Fredericktown,	Ohio,	10
Watches, .	N. P. Stratton, .	Waltham,	Mass.	3
Water Closet, .	J. Edelman, .	Philadelphia,	Penna.	24
——— .	John Keane, .	City of	N. Y.	31
——— Seat for .	K. Spencer, .	Minneapolis,	Min.	17
——— Closets,—Valves for	J. E. Boyle, .	Brooklyn,	N. Y.	3
——— from Wells,—Delivering	J. W. Wheeler, .	Cleveland,	Ohio,	17
——— Gauge, .	R. and G. E. Tower, .	Astabula,	"	24
——— Raising .	Leonard Gillett, .	N. Colebrook,	Conn.	17
——— .	H. B. Barber, .	Scott,	N. Y.	31
——— Wheel, .	V. M. Baker, .	Elkland,	Penna.	17
——— Gates, .	A. Morehouse, .	Farmer,	N. Y.	3
——— Wheels, .	H. H. Richardson,	Barre,	Vt.	24
Wax,—Substitutes for .	Campbell Morfit, .	City of	N. Y.	3
Weighing Apparatus,	E B Furlong & T Leavitt,	Charlestown,	Mass.	10
Whiffle-trees,—clevis for attach'g	L. S. Taylor, .	Lamville,	Ill.	24
Window Sashes,—Rollers for .	C. F. Brown, .	Bridgeport,	Conn.	17
———Sash Supporters,	S. Cooper, .	Windsor,	"	3
Wind-mills, .	E. F. Edwards, .	Le Roy,	Ill.	24
Wool,—Burring .	E. J. McCarthy, .	City of	N. Y.	10
Wrench, .	J. E. Neill, . .	"	"	24
Yarn,—Manufacture of .	F Vouillon & F Tavernier	Paris,	France,	31

EXTENSIONS.

Hat Bodies,—Making .	Wm. Fasket, .	Meriden,	Conn.	24
Mattresses, .	W. H. Robertson,	New London,	"	3

ADDITIONAL IMPROVEMENTS.

Churns,—Operating	A. G. Brush, .	Great Bend,	Penna.	10
Water Wheel, .	S. Richardson, .	Jericho,	Vermt.	17

RE-ISSUES.

Bands,—Wrought Iron .	C L Crowell & R Smith,	Peori,	Ill.	24
———Contracting Metal	" "	"	"	24
Bed Bottoms, .	Tyler Howe, .	Cambridgeport	Mass.	17
Hair Brush Handles,—Finishing	T. Mitchell, .	Lansingburg,	N. Y.	17
Grain&Grass Harvesters,(7 pat's)	Cyrus Wheeler, Jr.,	Poplar Ridge,	"	3
————(2 ")	Jesse Urmy, .	Wilmington,	Del.	3
Pictures,—Exhibit'g Stereoscopic	A. Beckers, .	City of	N. Y.	31
Roofs,—Sheet Metal .	Lucian Fay, .	Cincinnati,	Ohio,	24
Washing Machine,	W. H. Tambling, .	Berlin,	Wis.	17
Wrench,—Screw .	Amy Coes, .	Worcester,	Mass.	3

DESIGNS.

Bedsteads, . .	P. C. Cambridge, Jr.,	Enfield,	N. H.	24
Carpet Patterns, (2 cases,)	H. G. Thompson, .	City of	N. Y.	24
Combs,—Back .	Abel Gray, .	WappingersFalls	"	24
Fire Dogs, . .	T. W. Lillagore, .	Philadelphia,	Penna.	10
——— .	" " .	"	"	24
Floor Oil Cloth, .	James Bogle, .	Newton,	Mass,	31
Pumps, .	Birdsell Hally, .	Lockport,	N. Y.	24
Stoves, . .	S. W. Gibbs, .	Albany,	"	10
——— Doors of Cooking	N. S. Vedder, .	Troy,	"	3
———— .	" & A Murray	"	"	3
——— Side Plates of	" . .	"	"	3
———— Box	" & E. Ripley,	"	"	3
Trade Marks, .	James Meyer, Jr., .	City of	"	3
——— . .	N. Ezekiel, .	Richmond,	Va.	24

FEBRUARY, 1860.

Acoustics, .	D. D. Stelle, .	N. Brunswick,	N. J.	14
Amalgamators, .	George W. Carter, .	San Francisco,	Cal.	7
Axes,—Manufacture of	J. Lippincott, .	Pittsburgh,	Penna.	21
Bagasse Furnaces, . .	Charles Neames, .	New Orleans,	La.	14
Barrel Head,—Submerging	N. B. Cleveland, .	Waupun,	Wis.	21
Bedstead,—Folding .	D. Bach and R. Krenkel,	City of	N. Y.	28
———— .	S. Gillespie, .	"	"	28
———— .	Wm. C. Lutz, .	Jacob's Church,	Va.	28
———, Invalid .	Wm. Swift, .	Brooklyn,	N. Y.	14
———, Wardrobe .	Wm. Berg, .	City of	"	28
Beds, Sofas, &c.,—Springs for	John H. Crane, .	Charlestown,	Mass.	7
Bee-hives, .	A. W. Geahart, .	Beallsville,	Ohio,	14
Bell Pull, . .	C. J. Bradbury, .	Boston,	Mass.	28
Bellows, .	J. B. & J. A. Maxwell,	Allegheny,	Penna.	7
Belting,—Machine, .	T. J. Mayall, .	Boston,	Mass.	7
BilliardCues,—Attach'g Leather,	Wm. L. Aldrich, .	Atlanta,	Ga.	14
Blind Operators, .	L. N. Fay & W. Mason,	Warren,	Mass.	14
———— .	Jasper Johnson, .	Geneseo,	N. Y.	28
Boot Vamps.—Cutting	E. L. Vertrees, .	Howe's Valley,	Ky.	14
Boots and Shoes,—cutting Soles	W. G. Greeley, .	Hingham,	Mass.	14
Boring or Mortising Machines,	J. M. Kendell, .	S. Hardwick,	Vt.	14
Boring Wells, .	Joseph M. Butler, .	Oxford,	Miss.	28
Bottles,—Forming Necks, &c.,	R. McLardy, .	Pittsburgh,	Penna.	28
Bracelet Fastenings, .	J. Bissinger, .	City of	N. Y.	28
Braiding Machines, .	Edward B. Day, .	Boston,	Mass.	7
Brakes for Railroads, .	C. R. Davidson, .	Brooklyn,	N. Y.	7
Brakes,—Self-acting	Wm. A. Gibson, .	City of	"	7
Bread Slicer, .	James Stilley, .	Cincinnati,	Ohio,	28
——— .	H. F. Bond, .	Waltham,	Mass.	21
Brick Presses, .	J. S. Elliott, .	W. Needham,	"	14

Calender,—Counting House	John Bryner, .	Peoria,	Ill.	28
Cane Juice,—Defecating .	D. F. Boyd, .	Mansfield,	Ohio,	7
Caoutchouc Composition,	A. Willman, .	City of	N. Y.	21
——— &c.,—Working	Thomas Sault, .	Seymour,	Conn.	14
Carriage Thills,—Attaching	C. B. Wood, .	City of	N. Y.	7
——— Attachment	H. E. Clinton, .	Woodbridge,	Conn.	14
——— Securing	C. B. Wood, . .	City of	N. Y.	7
——— Tops, .	J. M. Freeman, .	Belleville,	"	14
——— Wheels,—Boxes of	Wm. Sheep, .	Catherine,	"	28
Cartridge Cases,—Percussion	Ethan Allen, .	Worcester,	Mass.	14
Carts,—Weighing .	G. M. Barth, .	Philadelphia,	Penna.	14
Chair and Crib,—Combined	S. Ray & M. R. Shalters,	Alliance,	Ohio,	7
Churns, .	Edwin Ward, .	City of	N. Y.	14
——— . .	Abner Willson, .	Colden,	"	14
——— .	E. B. Clement, .	Barnett,	Vt.	21
——— . .	A. W. Cunningham, .	W. Middleton,	Penna.	28
Cleaning Tumblers, &c.,	T. S. Harris, .	Boston,	Mass.	28
Clothes Dryer, .	R. Merrill, . .	Elmyra,	N. Y.	21
Coal,—Breaking .	I. P. Lykens, .	Pottsville,	Penna.	14
——— .	George E. Hoyt, . .	Brooklyn,	N. Y.	21
—— Carts, . .	R. Heckscher, .	City of	"	7
—— Oil,—Distilling	F. W. Willard, .	"	"	28
Coffee Mills, .	J. and E. Parker, .	Meriden,	Conn.	7
Coin Detector. .	H. Maranville, .	Clinton,	Ohio,	14
Cooking Utensils, .	B. W. Dunklee, .	Boston,	Mass.	14
Corn Shellers, .	S. W. Rychman, .	Pontiac,	Mich.	7
Cotton Gins, .	W. W. Howell, .	Columbus,	Miss.	28
Cotton Seed Planter, .	L. Acree, . .	Taliaferro,	Ga.	14
———	Abner Carey, .	Rome,	"	14
Cultivator Teeth, .	G. C. Aiken, .	Nashua,	N. H.	14
Cultivators, .	Abner Carey, .	Rome,	Ga.	14
——— . .	J O Harris & WF Slewder	Ottawa,	Ill.	14
——— .	T. Murphy, .	Cincinnati,	Ohio,	14
——— . .	Joseph Vowles, .	New Hudson,	Mich.	14
Dish Cloth Holder, .	W. J. Johnson, .	Newton corner,	Mass.	21
Drains,—Underground .	A. Watson, .	London,	Ohio,	28
Drawers,—Furniture	H. R. Taylor, .	Roxbury,	Mass.	21
Drill, . .	G. C. Taft, .	Worcester,	"	28
—— Chuck, . .	Jacob Fox, .	Philadelphia,	Penna.	7
Engraver's Vise, .	A. H. Wood, .	Boston,	Mass.	21
Egg-Beater, . .	James M. Jay, .	Canton,	Ohio,	7
—— Cup,—Spring .	Henrietta G. Batty .	Springfield,	Mass.	14
Evaporating Saline Liquors,	Charles Pope, .	Syracuse,	N. Y.	14
Fan Blowers, . .	J. B. Charles, .	Ashland,	Ohio,	14
Fences, .	S. Denton, .	Pen Yan,	N. Y.	21
Fertilizers, . .	A. Rolland, .	Toulouse,	France,	7
File for Papers and Letters,	J. B. McEnally, .	Clearfield,	Penna.	28
Files,—Sharpening .	W. B. Gillett, .	Auburn,	N. Y.	7
Fire Alarm, .	W. D. Grimshaw,	Newark,	N. J.	28
——-Arms,—Projectiles for	B. Swain, .	Washington,	D. C.	21
——-Escape, . .	G. Heydrick, .	Philadelphia,	Penna.	14
Fishing Reels, .	M. S. Palmer, .	New Bedford,	Mass.	28
Folding Paper for Bookbinders,	G. K. Snow, .	Watertown,	"	14
Furnaces for Plating Iron, .	Charles Wray, .	SanFrancisco co.	Cal.	21
———, Grates for	T. E. Purchase, . .	Danville,	Penna.	14
Gag Runner, .	W. Robotham, .	Newark,	N. J.	14
Gas Lights,—Extinguishing	H. K. Symmes, .	Newton,	Mass.	14
——Retorts, . .	J. Davis and S. Chaddock,	Boston,	"	14
Gates,—Opening and Closing	John H. Nevins, .	Ogdensburg,	N. Y.	28
Glue,—Manufacture of .	L. Reid and J. Rogers,	City of	"	28

Gold Separators, .	R. H. Dunning, .	N. San Juan,	Cal.	7
Grain Mills, . .	J. W. Wheeler, .	Cleveland,	Ohio,	21
—— Separators, .	B. F. Trimmer, .	Rochester,	N. Y.	14
———— .	L. B. Corbin, .	Dryden,	"	28
Gridirons, .	E. Webster, .	Hartford,	Conn.	14
Grinding Mills, .	Joel Bryant, .	Brooklyn,	N. Y.	14
———— .	O. W. Stanford, .	Cincinnati,	Ohio,	14
———— .	A. W. Sweet, .	"	"	21
Guard or Gas Cocks,	John W. Lyon, .	Brooklyn,	N. Y.	21
Gunpowder,—Applic'n to Projec's	E. O. C. Ord, .	United States	Army,	14
Harness Breeching & Breast Plates,	E. Brickett, .	Minot,	Maine,	14
Harrows, .	N. A. Patterson, .	Kingston,	Tenn.	14
Harvesters, . .	S. and J. H. Buser, .	Warner,	Ill.	14
———— ..	P. Flickinger, .	Hanover,	Penna.	14
———— . .	Edmond Peck, .	San Jose,	Cal.	14
———— .	C. B. Withington,	Rock,	Wis.	21
———— . .	W. A. Vertrees, .	Winchester,	Mo.	28
Head Rest, .	J. W. Lockwood, .	City of	N. Y.	7
Hinges, . .	James Jones, .	Rochester,	"	7
Horse Powers, .	Worden P. Penn, .	Belleville,	Ill.	21
———— .	N. S. Dodge, .	Indianapolis,	Ind.	28
Hot-Air Engine, .	S. Wilcox, Jr., .	Westerly,	R. I.	14
Hubs,—Metallic Carriage .	H. Boardman, .	Lancaster,	Penna.	14
Hydraulic Engine, .	J. F. Burgin and A. Koch,	Williamsport,	"	14
Indicator,—Street Registering	Adolph H. Rau, .	Philadelphia,	Penna.	7
Inkstands, . .	Max Braun, .	Brooklyn,	N. Y.	21
Iron,—Bars of Cast or Wrought	C. McCammon,	Albany,	"	14
Knitting Machines, .	C. J. Appleton, .	Philadelphia,	Penna.	14
Lamps, . .	S. Guthrie, .	New Orleans,	La.	14
——— .	C. Von Bonhorst, .	Hancock,	Md.	21
———, Burners for Vapor .	H W Dopp & W K Mead,	Buffalo,	N. Y.	21
———, Generating Vapor in	Wm. S. Mead, .	"	"	7
———, Vapor .	L. T. Conover, .	Philadelphia,	Penna.	28
———— .	H. Johnson, .	Washington,	D. C.	28
Lanterns, .	T. B. DeForest, .	City of	N. Y.	14
——— . .	John B. Jones, .	Williamsburg,	"	28
——— Carrier, .	S J Shaw & H J Batcheldor,	Marlborough,	Mass.	28
Last Holders, . .	A. G. Mach, .	Rochester,	N. Y.	21
Lathes,—Feed Nuts for	W. A. Patrick, . .	Ludlow,	Vt.	14
——— for Irregular Forms,	D Werst & A Puderbaugh,	Waltz Town'p,	Ind.	14
Leather,—Finishing .	W. P. Martin, .	Salem,	Mass.	28
——— Polishing	George S. Adler, .	Philadelphia,	Penna.	7
——— Trimming, &c. .	W. H. Rounds, .	Campello,	Mass.	7
Life Preservers, .	Norman Platt, .	Jackson,	Miss.	7
Locks, . . .	G. and G. F. Elliott,	Manchester,	Conn.	21
——— .	Henry Isham, .	New Britain,	"	28
——— Bolts for Door .	E. Parker, .	West Meriden,	"	7
——— on Hoops,—Cutting, &c.	A. H. Crozier, .	Oswego,	N. Y.	21
——— Permutation, .	W. A. Carpenter, .	Elgin,	Ill.	21
Looms, .	T. Lovelidge, .	Philadelphia,	Penna.	14
——— . .	J. J. Kendell, .	Corinth,	Miss.	28
Malt Kilns,—Floors of	T. S. Smith, .	Cincinnati,	Ohio,	21
Meat Chopper, .	H. D. Musselman,	Lancaster,	Penna.	28
Metal,—Bending Sheet	O. W. Stow, .	Plantsville,	Conn.	28
———Joining Plates of	Enoch Jacobs, .	Cincinnati,	Ohio,	21
Mills, . .	G. D. Jones, .	City of	N. Y.	21
Moulding Machines,	E. M. Smith, .	Indianapolis,	Ind.	21
Mortising Machine, .	W. Nangel. .	Philadelphia,	Penna.	14
Moth Traps, .	Joseph M. Heard, .	Aberdeen,	Miss.	7

Motion,—Changing .	W. H. Lazelle, .	City of	N. Y.	7
————	C. B. Parsons, .	Burr Oak,	Mich.	28
Mowing Machine Cutters, .	Fisk Russell, .	Manchester,	N. H.	14
——— and Reaping Machines,	John Butter, .	Buffalo,	N. Y.	7
Musical Instruments, .	U C Hill & H J Newton,	Jersey City,	N. J.	28
Musquito Bar, .	T. S. Scoville, .	City of	N. Y.	21
——— Nets& WindowShades,	R. B. Burchell, .	Brooklyn,	"	14
Nail Machine,—Cut .	Joseph Berry, .	City of	N. Y.	14
—— Plate Feeder, .	J. Hoard and T. A. Searle,	Providence,	R. I.	28
Oyster Dredge, .	Wm. L. Force, .	Keyport,	N. J.	21
Paddle Wheel, .	Henry B. Fay, .	City of	N. Y.	7
Paint,—Composition for .	E. P. Emerson, .	Blairsville,	Penna.	28
—— Cans, .	G. M. Bligh, .	City of	N. Y.	28
Painting Bottoms of Vessels,&c.,	J. G. Fuller, .	Brooklyn,	"	28
Paper Rag Engines, .	Joseph Storm, .	Woonsocket,	R. I.	14
Pegging Machine, .	E. Townsend, .	Boston,	Mass.	7
Pen and Pencil Case, .	J. Richardson, :	City of	N. Y.	28
——Handle, .	W. A. Morse, .	Boston,	Mass.	7
——Rack, Cleaner, &c., .	H. R. Haskell, .	Marshall,	Mich.	28
Photographs,—Toning	J. C. Rutherford, .	Derby Line,	Vt.	7
Photographic Cameras, .	A. Semmendinger,	City of	N. Y.	21
———— Plate Shield,	W. Campbell, .	Jersey City,	N. J.	28
Photographing Bank Notes,	L. Eidlitz, .	City of	N. Y.	14
Piano-fortes,—Grand .	F. C. Lighte, .	"	"	21
————Keys,	H. W. Hendsley, .	New Haven,	Ky.	7
Ploughs, . .	R. H. Brooks, .	Greenville,	Ga.	14
——— .	E. B. Clark, .	Tallahassee,	Fla.	14
——— . .	S. O. Vaughn, .	De Kalb,	Ill.	28
——— .	W. H. Johnson, .	Richmond,	Ark.	14
——— Mould Boards for	W. W. Skinner, .	Davenport,	Iowa,	7
——— Mole .	E. and W. Parish,	Galesburg,	Ill.	21
———— .	S. Adams, .	Toulon,	"	28
———— .	G L Griffin & J H Carper,	Dallas City,	"	28
——— Steam .	G. W. Ramsey, .	City of	N. Y.	21
Policeman's Club, .	John L. Rowe, .	"	"	28
Post Office Stamp,	James Spear, .	Philadelphia,	Penna.	14
Press,—Laundry and Tailors'	G. W. Jennings, .	Boston,	Mass.	14
Presses, .	E. C. Belts, .	Huntsville,	Ala.	21
Price Indicator, .	Phineas Topham, .	Newark,	N. J.	7
Printing Presses, .	F. L. Baily, .	Boston,	Mass.	21
Propellers,—Marine .	Jos. Reynolds, .	Providence,	R. I.	14
Pumps, .	A. Reichard, .	Washington,	Mo.	7
——— . .	Birdsill Holly, .	Lockport,	N. Y.	14
——— .	S. G. Randall, .	Worcester,	Mass.	28
Railroad Car Wheels, .	W. W. Spafford, .	Peterborough,	N. H.	14
Railroad Cars,—Couches for	Edward C. Knight,	Philadelphia,	Penna.	28
————— Passenger	Thomas Castor, .	"	"	21
————— Ventilation	E. B. Forbush, .	Buffalo,	N. Y.	21
————— Running Gear	J. Grice and R. H. Long,	Philadelphia,	Penna.	21
——— Gates, .	R. W. Jenks, Jr., .	Providence,	R. I.	7
——— Switches, .	S. H. Hodges, .	Rutland,	Vt.	7
Rat Traps, . .	H. A. Ridley, .	Sommerville,	Tenn.	7
Razor Strops, .	T. J. Mayall, .	Roxbury,	Mass.	28
Reading Card, .	H. F. Bond, .	Waltham,	"	28
Refrigerator, .	Jones Yerkes, .	Philadelphia,	Penna.	21
Rice,—Hulling and Finishing	R. Anderson, .	Brooklyn,	N. Y.	21
Rivet and Bolt Machine, .	A. Reese, .	Pittsburgh,	Penna.	21
Rollers,—Screw Thread on	W. H. Howard, .	Philadelphia,	"	14
Rudders,—Hanging .	Marston & Billings,	Providence,	R. I.	7

Sacharine Juices, .	S. H. Gilman, .	New Orleans,	La.	21
—————— .	D B Neal & H C Emery,	Mt. Gilead,	Ohio,	21
—————— Defecating, &c.	Joseph C. Tucker,	City of	N. Y.	28
Sail Cringles,—Attachment for	A. M. Southworth,	Dorchester,	Mass.	21
Sails,—Reefing .	A. L. Simpson, .	Derham,	N. H.	28
Sausage Filler, .	Atkins & Hitchcock,	Plantsville,	Conn.	21
Saw Blades,—Buck	A. Pruyn, .	Albany,	N. Y.	21
—— Handles,—Fastening .	J. Neimever, .	Hamilton,	Ohio,	28
—— Logs,—Rossing	E. H. Stearns, .	Cincinnati,	"	7
Saws,—Grinding and Polishing	C. W. Hubbard, .	Pittsburgh,	Penna.	21
Sawing,—Cross-cut .	A. D. Hoffman, .	Belleville,	Mich.	7
Secretary Table, .	Frank J. Henkel, .	City of	N. Y.	14
Seed Drills, . .	Jonathan Smith, .	Tiffin,	Ohio,	14
—— Planters, .	John S. Huggins, .	Timmonsville,	S. C.	28
———— Hand .	F. Van Doren, .	Adrian,	Mich.	14
Seeding Machines, .	Aaron King, .	Westbrook,	Me.	14
—————— .	George Copeland, .	Gray,	"	28
—————— .	A. R. Root, .	Canton,	Mo.	28
Sewing,—Making Plaits in	F. A. Allen, .	Portsmouth,	N. H.	7
——— Machine, .	J. M. Smith, .	Somers,	N. Y.	7
—————— .	John Thomson, .	Worcester,	Mass.	7
—————— .	George Juengst, .	City of	N. Y.	14
—————— .	J. A. Davis, .	"	"	21
—————— .	J. E. A. Gibbs, .	Mill Point,	Va.	21
—————— .	H. W. Dopp, .	Buffalo,	N. Y.	28
—————— .	James Rowe, .	Cincinnati,	Ohio,	21
—————— Gages for	C. D. Wheeler, .	City of	N. Y.	14
Shingle Machine, .	S. Ruthenburg, .	Indianapolis,	Indiana,	7
—————— .	D. Nicholson, .	Lockport,	N. Y.	14
—————— .	J. H. and A. E. Redstone,	Indianapolis,	Indiana,	28
Ships,—Construction of .	R. F. Loper, .	Philadelphia,	Penna.	28
Shoe and Bag Holder,	J. Allender, .	New London,	Conn.	7
Shutters,—Metallic .	J. Hodgson, .	Indianapolis,	Indiana,	7
Skates, .	Charles A. Ruff, .	Boston,	Mass.	7
——— . .	J. R. Henshaw, .	Middletown,	Conn.	14
——— Heel Screws for	Jeremiah Heath, .	Providence,	R. I.	21
——— Manufacture of .	Enos B. Phillips, .	Cambridgeport	Mass.	14
——— Spring .	Daniel Lovejoy, .	Lowell,	"	14
———— .	John S. Mitchell, .	South Boston,	"	21
Sleds,—Portable .	Joseph Lamb, .	City of	N. Y.	14
Smut Mills, . .	A. Wulze, . .	St. Louis,	Mo.	14
Sofa Bedstead, .	J. F. C. Peikhardt,	City of	N. Y.	21
Soldering Irons, .	A. Burbank, .	Brooklyn,	"	14
Sole Cutting Machines,	G. W. Parrott, .	Lynn,	Mass.	28
Spinning Wheels,—Hand	C. Metheny, .	Greensburgh,	Indiana,	7
Springs,—Adjustable Carriage,	Ira Carter, . .	Champlain,	N. Y.	7
Starch,—Manufacture of .	Charles S. Irwin, .	Madison,	Indiana,	14
Staves,—Dressing .	W. H. Sloan, .	Buffalo,	N. Y.	14
Steam Boilers,—Feed Water for	Codling, Jr. & McCunniff,	Fairbanks,	Iowa,	28
——— ——— Safety casing for	S. Solliday, .	Sumneytown,	Penna.	28
———Engines,—Air Trap for	Thomas Sault, .	Seymour,	Conn.	28
———————Governor valves	W. G. Crutchfield,	Dayton,	Ohio,	28
———————Rotary .	R. F. Brower, .	City of	N. Y.	14
————————	Josephus Parsons, .	Carthage,	Ohio,	14
———Trap, .	Frank Douglass, .	Norwich, .	Conn.	7
Steering Apparatus, .	Daniel Jones, .	Boston,	Mass.	21
————————	J. T. Chabot, .	Buffalo,	N. Y.	28
Stop Cocks, .	Thomas Daniels, .	Toledo,	Ohio,	14
Stoves, . .	J. W. Colemant, .	Medway,	Mass.	14
——— Cooking .	S. S. Curtis, .	CrotonCorners,	N. Y.	21
—————— . .	C. O. Green, .	Troy,	"	21
——— and Ranges,—Cooking	R. D. Granger, .	Albany,	"	7

Straw Cutters,	D. J. Powers,	Madison,	Wis.	14
Studs,—Safety	L. DeMasure,	City of	N. Y.	14
Sugar Cutter,	C Kinsler & W Rosebnck,	"	"	14
———Juices,	John M Jones,	New Orleans,	La.	21
Surveying Compass,	G. W. Dickenson,	Breckenridge,	Va.	21
Tanning,	P. Daniels,	Le Roy,	N. Y.	7
———	W. R. Webster,	Gowanda,	"	21
———	C. L. Robinson,	Waukesha,	Wis.	21
Teaching Orthography, &c.,	H. B. Brown,	Huntington,	N. Y.	21
Tent Frame,	J. G. Dodge,	St. Louis,	Mo.	28
Thermostat,	H. A. Seymour,	Bristol,	Conn.	28
Thread,—Cutting and Pulling	T. Sullivan,	City of	N. Y.	21
Time Table for Railroads, &c.,	C. M. Plumb,	North Orange,	N. J.	14
Tire,—Bending	Mosher, Harris & Mosher,	Green,	N. Y.	14
Traps for Animals,	V. O. and J. R. Spencer,	Mansfield,	Penna.	7
———	William Tinsley,	City of	N. Y.	7
Tufted Work,	Emil Kellerman,	Moosop,	Conn.	14
Tuyere,	C. H. Thompson,	Orange,	Mass.	7
Twine Holder,	T. W. Brown,	Boston,	"	14
Umbrella Stands,—Locks for	Alfred M. Foote,	City of	N. Y.	7
Valve for Delivery of Liquids,	W S Mead & H W Dopp,	Buffalo,	N. Y.	21
Valves,—Slide	Noah Sutton,	City of	"	14
Vapor for Illumination,	W. H. Lanback,	Philadelphia,	Penna.	14
Veneers,—Cutting	Peter Weiler,	City of	N. Y.	28
Ventilating Apparatus,	G. B. Clark,	Leonardsville,	"	21
Vessels,—Construction of	Thomas Bell,	City of	N. Y.	28
Washing Machines,	Frazee Ayres,	Rahway,	N. J.	7
———	A. A. Washburn,	St. Johnsville,	N. Y.	21
———	L D Hunt & B B Hawse,	Morrisville,	Vt.	28
Water,—Freeing Ships' Hold f'm	J. W. Mackenzie,	San Francisco,	Cal.	14
——— Metres,	E. P. and J. N. Farrar,	City of	N. Y.	14
——— Proof Leather Goods,	S. La Forge,	Cleveland,	Ohio,	28
——— to Buildings,—Supplying	Thomas Hanson,	City of	N. Y.	21
——— Wheels,	P. H. Roots,	Connersville,	Ind.	21
Watches,	John Gordon,	New London,	Conn.	28
Weights,—Moving Heavy	Julien Quetil,	City of	N. Y.	7
Wind-wheels,—Regulating	W. D. Walker,	Livonia,	"	28
Window Sash Supporters,	David Bickford,	Westerly,	R. I.	7
Wrench,	A. C. Richards,	Newtown,	Conn.	7
Zinc,—Manufacturing Oxide of	I. M. Millbank,	Greenfield Hill,	Conn.	14

ADDITIONAL IMPROVEMENTS.

Revolving Fire Arms,	Josiah Ells,	Pittsburgh,	Penna.	21
Skate Fastenings,	T. P. Castello,	Buffalo,	N. Y.	28
Pump Packings,	Wasburn Race,	Seneca Falls,	"	28

RE-ISSUES.

Faucets,	James Powell,	Cincinnati,	Ohio,	21
Horse Power,—Endless Chain	G. Westinghouse,	Schenectady,	N. Y.	14
Ladies' Dresses,—Frame for	J. L. Palmenberg,	City of	"	7
Life Preservers to Vests,	R. L. Nelson,	Ocala,	Fla.	7
Mowing Machine,	G. C. Dolph,	West Andover,	Ohio,	21
Nut Machine, / Nuts,—Making	R. H. Cole,	St. Louis,	Mo.	21
Railroad Cars,—Coupling	B. E. Sampson,	Boston,	Mass.	21
———Frogs,	James M. Dick,	Buffalo,	N. Y.	21
Reaping & Mowing, (2 patents,)	J T Whitaker & C D Read,	St. Charles,	Ill.	7
——— "	" "	"	"	7
——— Machine,	Obed Hussey,	Baltimore,	Md.	28

Sewing Machines, . Stitches,—Process for forming	Wheeler&Wilson, M Co.,	Waterbury,	Conn.	28
Skates, .	N. C. Sandford, .	Meriden,	"	7
Steam Engines, (6 patents,)	F. E. Sickels, .	City of	N. Y.	21
——— Slide Valves of	R. C. Bristol, .	Chicago,	Ill.	7
Time Keepers,—Regulator for	R. S. Mershon, .	Philadelphia,	Penna.	7
Water Wheel, .	P. H. Roots, .	Connersville,	Ind.	28
DESIGNS.				
Carpet Patterns, .	Elemer J. Ney, .	Lowell,	Mass.	14
——— (2 patents,)	" .	"	"	28
Iron Railings, . .	Isaac De Zouche,	St. Louis,	Mo.	21
Sewing Machine, .	J. E. A. Gibbs, .	Mill Point,	Va.	28
Statuette,—S. A. Douglass,	L. W. Volk, .	Chicago,	Ill.	14
Stoves, . .	W. H. Smith, .	Newport,	R. I.	21
——— Cooking .	N. S. Vedder, .	Troy,	N. Y.	21
———. .	W. W. Stevens, .	Lowell,	Mass.	14
——— Parlor&Cook,(2 patents,)	N. S. Vedder, .	Troy,	N. Y.	14

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Adding Machines, .	John Ballou, .	Cincinnati,	Ohio,	13
Andiron, .	John B. Logan, .	Blountville,	Tenn.	27
Axles,—Arms of Carriage	A. J. Bell, .	Greenupsburg,	Ky.	20
Ash-Sifters, .	Lawrence F. Frazee,	N. Brunswick,	N. J.	13
Bedstead, .	Sylvanus Walker, .	Boston,	Mass.	20
Bee Hives, .	W. A. Flanders, .	Cleveland,	Ohio,	6
Belting,—Elastic .	Dennis C. Gately, .	Newtown,	Conn.	13
——— .	James & Sanford Peatfield,	Ipswich,	Mass.	13
Bench Clamp, .	George Cooper, .	Hartford,	Conn.	20
Bending Wood, .	Artemus Rogers, .	Painesville,	Ohio,	20
Bone Black,—Revivifying	William Mitchell,	City of	N. Y.	13
Book Ruler, .	Andrew J. Moser, .	"	"	13
Boot and Shoe Heels, .	George W. Keene,	Lynn,	Mass.	6
—— Crimping Machines,	Reuben Warren, .	Jefferson,	Ohio,	20
———	Nolen and Hinchman,	Paulsboro',	N. J.	20
Brakes,—Carriage .	Albertus Larrowe, .	Cohocton,	N. Y.	27
Brake,—Self-acting Wagon	George W. Morgan,	Prattsburgh,	"	20
Brick Molds, .	J. F. Schuffenecker,	Keokuk,	Iowa,	27
Bridges,—Floating	Thomas Schofield, .	Grass Valley,	Cal.	20
———Securing Chords, &c.,	Francis C. Lowthorp,	Trenton,	N. J.	13
Bridle Reins, .	William Orton Williams,	Washington,	D. C.	13
Cables,—Surge Spring for Ship's,	Albert H. Wright, .	Philadelphia,	Penna.	13
Cane Coverers, .	John Allison, .	St.Martinsville,	La.	6
Car Couplings,	J. Bestwick Jr.&A Alden,	Dedham,	Mass.	20
—— Seats, .	F. I. Palmer, .	Knoxville,	Tenn.	13
——— .	Samuel McGregor,	Logansport,	Ind.	27
—— Springs, .	Walter J. F. Liddell,	Erie,	Penna.	6
Carriages,—Wheel&DressGuard	Walter R. Bush, .	Albany,	N. Y.	13
Casting,—Blackwashing Molds	W. and D. Ferguson,	City of	N. Y.	13
Chair,—Reclining .	Sarah D. Carman, .	Middletown,	"	20
——— .	Seth D. Woodbury,	Lynn,	Mass.	27
——— Self-adjusting	Marcus Stevens, .	Detroit,	Mich.	13
Churn, .	David Newbrough,	Clarksburgh,	Ind.	6
——— .	Jason W. Hardie, .	City of	N. Y.	13
——— .	Daniel H. Wiswell,	Buffalo,	"	13
——— . .	Pearson Embree, .	West Chester,	Penna.	20
——— .	James Sangster, .	Buffalo,	N. Y.	20
——— . .	William Morgan,	Middlebrook,	Va.	20
——— Dasher, .	Aaron C. Vaughn, .	Johnstown,	Penna.	6
Cider Mills, . .	E. H. Philo, .	Half Moon,	N. Y.	27
igar-heading Socket,	Thomas Thorp, .	City of	"	13

Coal Breaker, .	Philip Umholtz, .	Tremont,	Penna.	20
—— Distillation of .	H. P. Gengembre, .	Allegheny,	"	20
—— Dust,—Solidified Fuel from	E. D. Williams, .	Philadelphia,	"	6
—— Preparing .	E. and H. Mahew, Jr.,	Lancaster,	"	6
Coffee Pots, .	John Magee, .	Lawrence,	Mass.	6
——Roasters,	Reinhold Landstrom,	Boston,	"	13
Corkscrew, .	M. L. Byrn, .	City of	N. Y.	27
—— .	Philo Blake, .	New Haven,	Conn.	27
Corn Harvesters, .	H Gortner and J McCann,	Nashport,	Ohio,	6
—— Huskers, .	Samuel Johnston, .	West Shelby,	N. Y.	27
—— Planters, .	William M. Garee,	Granville,	Ohio,	6
—— .	Herman B. Hammon,	Bristolville,	"	6
Cotton Bales,—Iron Ties for	C. W. Wailey, .	Lexington,	Ky.	27
—— Cultivators,	Mark Snow, .	Auburn,	Miss.	27
—— .	Cullen Casey, .	Goldsboro',	N. C.	27
—— Hand Pickers,	W. B. Cargill, .	Waterbury,	Conn.	6
—— Plants,—Cutting up	B. F. Currier, .	Bath,	Maine,	6
—— Presses, .	Thomas H. McCray,	Tellico,	Texas,	13
—— Seed Planters,	Curran Battle, .	Warrenton,	Ga.	13
Couplings,—Car .	S. Daggett, .	Charleston,	S. C.	20
Crank Boxes, .	George Westinghouse,	Schenectady,	N. Y.	20
Cultivators,	F. O. Wilson, .	Mount Olive,	N. C.	6
—— .	Robert Craig, .	State Line City	Ind.	6
—— . .	Tdaddeus Scoville, .	City of	N. Y.	6
—— .	John J. Paxson, .	Middleton,	Ind.	6
—— . .	Jimpsey B. Netherland,	Louisville,	Ga.	6
—— .	W. W. Green, .	Chelsea,	Ill.	6
—— . .	John Guyer, .	Westport,	Conn.	13
—— .	Edward Julier, .	Beverly,	Ohio,	13
—— . .	C. M. and D. E. Hall,	Uniontown,	Ill.	27
—— .	William Bushnell, .	Easton,	Penna.	27
—— . .	George Smith, .	Baltimore,	Ohio,	27
—— .	Samuel Hoake, .	Frederick,	Md.	27
Curtain Fixtures, .	G L Kelty & T G Harrold,	City of	N. Y.	6
Die Stock, .	James Teachout, .	Waterford,	N. Y.	27
Distilling,—Apparatuses for	Franklin W. Willard,	City of	"	13
Ditching Machines, .	Austin Woolfolk, .	Iberville Parrish,	La.	6
——	John W. Barcroft,	Friendship,	Va.	13
Drain Tile Machines, .	John Hotchkiss, .	Yellow Springs	Ohio,	27
Dress-lifter, .	W. E. Stein, .	City of	N. Y.	20
Eyelit Machines, .	H. D. Walcott, .	Boston,	Mass.	27
Faucet,—Measure .	M. W. Nalton, .	Utica,	N. Y.	13
Felloes,—Machine for Bending	Solomon Moyer, .	Shimersville,	Penna.	20
Felting Machinery, .	Bloodgood and Johnson,	City of	N. Y.	6
Files,—Machine for Cutting	Dr. Theodore Burr,	Hastings,	Mich.	20
Fire-Arms,—Breech-loading	J. M. Wampler, .	London Co.,	Va.	6
——	N. L. Babcock, .	New Haven,	Conn.	20
——	C. Edward Sneider,	Baltimore,	Md.	20
—— Cartridges for	John W. Cochran, .	City of	N. Y.	20
—— Construction of	Ethan Allen, .	Worcester,	Mass.	13
—— Rifled, .	J. B. Atwater, .	Ripton,	Wis.	6
—— Revolving .	William H. Bell, .	Washington,	D. C.	20
—— .	J. Maslin Cooper, .	Pittsburgh,	Penna.	20
—— Self-loading	James D. Moore, .	Zanesville,	Ohio,	6
—— .	C. M. Spencer, .	S. Manchester,	Conn.	6
Fire-proof Column,—Double	J. B. Cornell, .	City of	N. Y.	20
Fires,—Extinguishing .	Charles Gustave Mueller,	"	"	6
Folding and Pasting Paper,	George K. Snow, .	Watertown,	Mass.	6
Forging Machine, .	William T. Leach,	East Wareham	"	20
Furnaces, .	Benjamin D. Evans,	Mt. Vernon,	Ohio,	20
—— Air-heating .	Richard T. Crane, .	Chicago,	Ill.	20

Furnace,—Portable	John B. Marvin,	City of	N. Y.	20
Fusible Alloy,—Metallic comps'n	Barnabas Wood,	Nashville,	Tenn.	20
Gas,—Manufacture of	S. T. McDougall,	City of	N. Y.	13
—— Metres,—Wet	William Richards,	Barcelona,	Spain,	20
—— Regulators,	E. T. Orne,	Boston,	Mass.	27
—— Retorts,	Richard E. Harrington,	Newark,	N. J.	20
———— Clay	John P. Kennedy,	Trenton,	"	13
—— Stoves,	E. A. Leland,	Jacksonville,	Ill.	20
Gate,	Jasper Johnson,	Geneseo,	N. Y.	6
Grain Cleaners,	Abram Gaar,	Richmond,	Ind.	13
————	George W. Osborn,	Centerville,	Mich.	13
————	A. T. Waldo,	Dryden,	N. Y.	13
—— Fans,	Peter Bailey,	FallsTownship	Penna.	13
Grinding Mills,	Wm. Stewart,	Philadelphia,	"	20
Grist Mills,—Collecting Toll	T. R. Van Gelder,	Damascus,	"	20
Gun Barrels,—Manufacture of	James Henry Burton,	Jefferson Co.,	Va.	20
Harrows,	Silas C. Schofield,	Freeport,	Ill.	13
——— Seeding	Henry Hewett,	San Francisco,	Cal.	27
Harvesters,	E. Ball and M. L. Ballard,	Canton,	Ohio,	20
————	G. E. Chenoweth,	Baltimore,	Md.	27
————	Edwin Jones,	Cross Roads,	Ohio,	27
————	Pells Manny,	Waddam'sGrove	Ill.	27
————	David Van Kleeck,	Cohocton,	N. Y.	20
———— Corn and Cane	D. P. Flynn & R. S. Hayes,	Le Roy,	"	6
———— Guard Fingers for	Robert Beans,	Johnsville,	Penna.	20
Hawse Pipe,	T. J. Southard,	Richmond,	Maine,	13
Hay Presses,	John H. Gove,	San Francisco,	Cal.	6
—— Rakes,—Horse	Henry Eastman,	Indianapolis,	Ind.	6
————————	A. B. Johnson,	Washington,	"	6
Hides,—Preparing	Dennis Aldrich,	St. Louis,	Mo.	6
Hoes,	Huntingdon Porter,	Cummington,	Mass.	6
Hog Elevators,	Daniel Kaufman,	Boiling Spring,	Penna.	6
Hoisting & Weighing Machines,	Joseph L. Dutton, Sr.,	Philadelphia,	Penna.	27
Hose Tubing,	Thomas J. Mayall,	Roxbury,	Mass.	20
Hot-air Register,	Thomas E. McNeill,	Philadelphia,	Penna.	13
Hot Water Apparatus,	Jacob F. Hunter,	City of	N. Y.	27
Hub for Carriage Wheels,	J. F. Beckwith,	South Alabama,	"	27
Insects,—Destruction of	Frank G. Johnson,	Sag Harbor,	N. Y.	27
Jacks,	Reuben Wood,	Grand Ledge,	Mich.	13
Jewelry,—Embossing Designs	William Riker,	Newark,	N. J.	13
Knife and Fork Cleaner,	John Protz,	Easton,	Penna.	13
—— Handles,	Lucius Carrier,	East Douglas,	Mass.	6
—— Sharpener,	Septimus C. Stokes,	Manchester,	N. H.	6
Knitting Machines,	John Chantrell,	Bristol,	Conn.	13
Lamps,	Zuriel Swope,	Lancaster,	Penna.	13
—— Burners for Vapor	Butler, Hosford & Smith,	Brooklyn,	N. Y.	6
Lanterns,	Thomas B. De Forest,	City of	"	27
————	Augustus Tufts,	Malden,	Mass.	13
Lathes,—Centering Chuck for	Elizabeth Keagg,	Mineral Point,	Penna.	20
——— Turning	William Sellers,	Philadelphia,	"	13
Letter-boxes,—Drop	John North,	Middletown,	Conn.	13
Life Boat,—Surf	John R. Grace,	Brooklyn,	N. Y.	6
Liniments,—Anti-rheumatic	John Adam Scheutz,	St. Louis,	Mo.	6
Locomotives,—Feed-water appa's	R. A. Wilder,	SchuylkillHa'n,	Penna.	27
Lubricating Journals,	E. Andrews & J. H. Carr,	Palo Alto,	"	13
Lubricators,	Levi S. Lapham,	Providence,	R. I.	20
Machine Cards,—Cleaning	Horace Woodman,	Biddeford,	Maine,	13
Marble,—Polishing	William Emmett,	Galveston,	Texas,	20
Marine Propellers,	Henry W. Herbert,	Herbertsville,	Va.	27

Mattress,—Ventilating Spring	Robert W. Geraghty,	Newark,	N. J.	27
Mill Spindles, .	Samuel P. Ruff, .	Weaver's Stand,	Penna.	6
Mills,—Applying Horse-power to	B. E. Orton, .	Lyndon,	Ill.	13
Millstone Dress, .	C. V. Littlepage, .	Austin,	Texas,	20
Mortising Machine, .	Aaron C. Vaughn, .	Rainsburg,	Penna.	6
Motive Powers, .	Frederick M. Ruschhaupt,	City of	N. Y.	20
Mowing and Reaping Machines,	Vosco M. Chafee, .	Xenia,	Ohio,	20
Mop and Scrubber, .	Robert Price, .	City of	N. Y.	6
Nail Machines,—Horse-shoe	William Tallman, .	Providence,	R. I.	27
Newspapers,—Print'g Addresses.	Tiffany & Soule, .	Xenia,	Ohio,	20
Odometer, . .	John M. Whitney, .	Bolton,	Mass.	20
Oil from Coal,—Distilling	C. J. Van Wyck, .	City of	N. Y.	20
Ore-washer, . .	George E. Mills, .	"	"	13
Organ Pipes, .	Jackson Gorham, .	Bairdstown,	Ga.	13
Paddle Wheel, .	Collyer & Patterson, .	Philadelphia,	Penna.	27
——— Feathering	Wm. L. R. Mattason,	Rochester,	N. Y.	13
Paper,—Manufacture of Straw	R.T., I.W., & A.I. Smart,	Troy,	"	27
——— Pulp,—Straw for	J. B. Palser & G. Howland,	Fort Edward,	"	20
Pavements,—Mode of Making	Samuel D. Tillman, .	City of	"	27
Pessaries, .	Francis F. Wells, .	Texana,	Texas,	13
Piano-fortes, .	Spencer B. Driggs, .	City of	N. Y.	13
Piled Fabrics,—Manufacture of	Charles Miller, .	"	"	27
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EXTENSIONS.

ADDITIONAL IMPROVEMENTS.

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JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE PROMOTION OF THE MECHANIC ARTS.

DEVOTED TO

MECHANICAL AND PHYSICAL SCIENCE,

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AND THE RECORDING OF

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““# JOURNAL

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PROMOTION OF THE MECHANIC ARTS.

JULY, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Double Cylinder Expansion Marine Engines. By ALBAN C. STIMERS, Chief Engineer U. S. Navy.

IN the year 1781 Jonathan Hornblower obtained his patent for using two cylinders, one larger than the other, to get the benefit of the expansion of the steam, which, after impelling a small piston with steam of the boiler pressure, was to pass into the large cylinder and act upon the greater number of square inches with a less pressure per square inch, thus rendering the two cylinders approximately equal in power. This was before the days of "patent cut-offs," and indeed the intention of Hornblower was the same as that of the cut-off inventors of the present day, a moderate expansion only was intended, the steam was to follow the small piston during the whole stroke and steam of a very moderate pressure was to be used. After getting his patent, however, he could make no use of it as Watt's claims covered every variety of engine to which such a principle could be applied.

It is noteworthy that this patent of Hornblower's was the first public announcement that there was any benefit to be derived from the expansion of the steam when not flowing freely from the boiler; although Watt had made a practical application of the principle in an engine erected at Soho, near Birmingham, in 1776, five years before, by closing his induction valves before the piston had arrived at the end of the stroke in an ordinary single cylinder engine, as is the common practice at the present day.

Hornblower's mode of effecting the expansion has had many advo-

cates even since the introduction of excellent modes of effecting expansion in a single cylinder, but as a general rule it has only been by amateur engineers, and as a consequence, but few have been actually built.

The only application of them to marine purposes in this country which has fallen under my observation, were those of the steamboats *Independence*, *Oregon*, and *Buckeye State*. The first of these plied upon the Hudson River more than thirty years ago, and had what is known in this country as a square engine. The steam first acted upon two small pistons in vertical cylinders standing one upon each side of a large one, into which the steam passed from both the small cylinders after the completion of the stroke of their pistons. The piston-rods from each of the three cylinders were attached to the same crosshead.

The engine of the *Oregon* was a non-condensing horizontal one, built at Pittsburgh, Pa., in 1847, and the boat plied on our Northern Lakes during five or six years and was finally destroyed by fire in Chicago. The small high pressure cylinder was directly in the rear of the large low pressure one, a piston-rod passing through stuffing-boxes in the rear of the large, and the head of the small cylinder connected the two pistons rigidly together. This was a very awkward arrangement, as the steam, after acting upon the rear side of the small piston, had to traverse a steam pipe after leaving the cylinder, of more than twice the length of the stroke before it could act upon the front side of the large piston.

The following are the dimensions of the cylinders:

Length of stroke . . .	10 ft.
Diameter of large cylinder, . . .	48 ins.
" small " . .	28 "
Ratio of areas, . . .	about 3 to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	three.
Pressure of steam carried in boilers, . .	80 lbs.

Although this engine was unpopular, it is generally acknowledged to have been economical upon fuel.

The *Buckeye State* was built in Cleveland, Ohio, in 1851 as a passenger boat for Lake Erie. The engine, with the exception of the cylinder, was the ordinary condensing, vertical, overhead beam, with lifting air-pump. The small high pressure cylinder was directly within the large low pressure one, which thus had necessarily an annular piston; both pistons were connected to the same crosshead by three piston-rods, one from the central and two from the annular piston. In this arrangement the steam was required to pass through pipes equal in length to the cylinders themselves after leaving the small piston before it could act upon the large one.

The cylinders were of the following dimensions:

Length of stroke, . . .	11 ft.
Diameter of large cylinder, ...	40 and 80 ins.
" small " . .	37 "
Ratio of areas, . .	3½ to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	3½.
Pressure of steam carried in boilers, . .	50 lbs.

This boat would maintain the same speed as others of the same

dimensions running between Buffalo and Detroit on Lake Erie and consume but two-thirds the coal.

The mechanical performances of the engine were excellent, and it won its way through distrust and prejudice to high favor with all classes, and has at last only succumbed to the railroads, the same as all other paddle steamers on the Lakes.

In the course of a cruise in the Frigate *Merrimack*, in the year 1859, on the western coast of South America, I found that an English line of mail steamers—the Pacific Steam Navigation Company—had sent two vessels to England and had the double cylinder expansion engines of Randolph, Elder & Co. put into them, and that the result was a remarkable economy. At Callao the agent of the Company, Mr. Peters, sent an invitation through our Flag Officer for me to visit the Steamer *Callao*, at that time in port, in order that I might learn the particulars of what he believed was a great improvement in steam engineering. I accepted the invitation, and afterwards at Panama, by the polite invitation of Mr. Jameson, the chief engineer of the line, I visited the *Inca*, the *Valparaiso*, and the *Lima*. In the last named I made a trip down the Bay of Panama from the port to Taboga, a distance of nine miles, and thus had an opportunity to thoroughly examine the machinery when in operation. They are of beautiful workmanship, and I think I never saw machinery where the designer had been so entirely successful in combining compactness with easy access to every part requiring attendance, either when running or when overhauling for repairs.

There are two pairs of double cylinders, one forward and one abaft the paddle shaft. They are inclined to an angle with each other of ninety degrees and are direct-acting. There are but two crank-pins, one of which is articulated by the two small high pressure cylinders and the other by the two large low pressure cylinders, two connecting-rods engaging each crank-pin. The two pairs of cranks are directly opposite each other, and the small and large cylinders are side by side. Thus, when the small piston goes up the large one goes down and *vice versa*, making the steam passages from the high to the low pressure cylinders the shortest possible.

Description of Engine.	Space Occupied.		Weight.	
	Total.	Per cub. ft. of cylinder.	Total.	Per cub. ft. of cylinder.
	cub. feet.	cub. feet	lbs.	lbs.
The American overhead beam, (1 cylinder,)	14,000	44·408	280,000	885
The side lever, . . "	12,000	38·064	295,000	935
The oscillator, . "	8,000	25·376	220,000	697
The double cylinder expansion (4 cylinders,)	10,000	17·000	448,000	760

Although a strict comparison cannot be made, an idea of their compactness may be formed by the above spaces and weights required in the ship for a single engine. The side lever and oscillator having cylinders 85 inches diameter and 8 feet stroke, and the American beam an equal capacity, but of 70 inches diameter and 10 feet stroke.

The space occupied includes all passages about the engines, but not that part of the overhead beam which is up out of the way above deck.

The small cylinders have induction valves only. They are the grid-iron slide with sufficient lap to act as expansion valves. Between the small and large cylinders are slide valves of the ordinary character, without lap, having their faces toward the large cylinders, and when the port is uncovered by the valve the communication is free from the small to the large cylinder at one end and from the large cylinder to the condenser at the other. The cylinders are entirely surrounded with steam from the top of the steam drums of the boilers, where the temperature is from 100° to 150° F. higher than at the surface of the water. This superheating is effected by having steam drums 12 feet in height, with the uptakes from the tubes to the smoke pipe passing through them; the fire surface thus exposed to the steam being about 17·5 per cent. of the total fire surface.

As it may be useful to some readers to know the full dimensions of the vessel, boilers, and engines, I give them complete of the *Lima*, those of the *Valparaiso*, *Callao*, and *Bogota* being essentially the same.

Hull.—Length on deck, 257 ft. Length between perpendiculars, 251 ft. Breadth extreme, 30 ft. Depth of hold, 17 ft. Do. to spar deck, 25 ft. 4 ins. Length of engine space, including bunkers, 71 ft. Do. exclusive of do. 38 ft. 9 ins. Tonnage, (English old measurement,) 1115 44-94 tons. Do. (do. new do.) gross, 1461·24 tons. Do. (do.) engine room, 295·61 tons. Do. (do.) register, 1165 63 tons. Displacement at time of trial, 1345·00 tons. Area of midship section at do. 302 sq. ft. Draft of water at do. forward, 11 ft., aft, 12 ft. Speed at do. 12 knots.

Boilers.—Kind—Multitubular, horizontal fire tube, iron tubes. Number of pieces, two. Length of each, 12 ft. Breadth of each, 9 ft. 6 ins. Height, exclusive of steam drum, 13 ft. 6 ins. Do. inclusive of do. 25 ft. Number of tubes, 516. Diameter of do. outside, 4¼ ins., inside, 4 ins. Length of do, 6 ft. 6 ins. Number of furnaces, 6. Length of grate bars, 6 ft. 6 ins. Breadth of each furnace, 3 ft. 6 ins. Grate surface, 136·5 sq. ft. Fire surface, 3200 sq. ft. Ratio of fire to grate surface, 23·44 to 1. Diameter of smoke-pipe, 5 ft. Height of do. above grate, 45 ft. Cubic contents of water and steam space, 1000 cub. ft. Do. of combustion chambers and furnaces, 480 cub. ft. Air space through fire bars, about 50 sq. ft. Do. through tubes, 50 sq. ft. Do. through smoke-pipe, 19·6 sq. ft. Diameter of uptakes through steam drum, 2 ft. Number of do. six. Surface of do. exposed to steam, 560 sq. ft. Combustion of coal per hour at time of trial, 2590 lbs. Pressure of steam at do. 24 lbs.

Engines.—Kind—Inclined direct-acting, double cylinder expansion. Number of cylinders, four, two high pressure and two low pressure. Diameter of high pressure cylinders, 52 ins. Do. of low do. 90 ins. Ratio of areas, about three to one. Length of stroke, 5 ft. Area of steam passages, (6×24,) 144 sq. ins. Condenser, common jet, capacity, 400 cub. ft. Air pump, vertical single acting, lifting, capacity, 17 cub. ft. Vacuum at time of trial, 28 ins. Horses power at time of trial, 1150.

Paddle Wheels.—Kind—Feathering, with Penn's eccentrics and iron floats. Diameter over floats, 25 ft. 2 ins. Length of do. 8 ft. 2 ins. Breadth of do. 3 ft. Thickness of do. ¾-in. Number of do. in each wheel, twelve. Immersion at time of trial, 4 ft. Total weight of engines, 200 tons. Do. of boilers, 50 tons. Do. of water in do. 18 tons. Do. of both paddle wheels, 40 tons. Do. of coal when bunkers are filled, 250 tons.

The *Lima* and *Bogota* were in constant use 9000 miles from England, and were detached from their service in the line and sent this

great distance under steam, to have machinery removed which was of modern construction and in every respect mechanically good, to receive new, of a type which had yet to become known to the general engineering profession. Much more than ordinary advantages must be obtained by any engineering improvement to induce so conservative a body as an English steamship company to put themselves to so great an inconvenience and outlay.

The comparative economy of the old and the new machinery of these vessels may be gathered from the following several facts.—

The *Valparaiso*, with the new machinery, burned 640 tons of coal the round trip between Panama and Valparaiso, at the same time that the *Lima* and *Bogota*, with the old machinery, consumed 1150 tons.

The *Lima* was 48 steaming days in going from Callao to Liverpool, and burned 1900 tons of coal. On her return, after being fitted with the new machinery, she steamed only 42 days, and burned but 1000 tons of coal; and her commander, Capt. Wells, informed me that the weather was more favorable on the passage *to* England than on his return.

The *Bogota*, on her first passage out, in April, 1852, averaged on the passage to Madeira 9·75 knots with a consumption of 4256 lbs. of coal per hour. On her passage out, after receiving the new machinery, in September, 1859, she averaged on the passage to St. Vincent, Cape de Verde, 10·42 knots, with a consumption of 2128 lbs. per hour.

The Chief Engineer of the *Lima* informed me that her coal bills for the round trip of 5200 nautical miles, were 7500 dollars less than they were previous to the change in the machinery.

These are the crude facts which establish the great gain in economy of fuel; but, in addition to this, the tonnage of the vessels were considerably increased by the lesser weight and space of the new machinery, and the difference in the coals required to be carried.

It can easily be understood, therefore, why the company, after becoming convinced that the above results could be obtained, should put themselves to such great inconvenience and expense. It is, however, pretty well understood by American engineers, that English marine engines generally, though possessing great mechanical excellence, develop considerably less power per pound of coal than American engines. To enable the American engineer, then, to judge of the propriety of introducing machinery of that character into our steam marine, it is necessary to compare them with one of our most economical American engines. Those of the U. S. Frigate *Saranac* present, perhaps, the best sample that could be taken, as they are thoroughly American engines, and are very economical.

There is no question but that the boilers of the *Saranac* and those in general use in our navy at the present time, are decidedly superior to those which have been furnished to the Pacific Steam Navigation Company, by Randolph, Elder & Co. The question is, therefore, solely between the two kinds of engines.

To make a strict comparison between engines, independent of the boilers, it is neccssary to compare the power obtained with the water

required to be evaporated. This can be done with little difficulty from correctly-taken indicator diagrams from engines in good working order. There is also a great advantage in this mode of comparison, in that no dependence is required to be placed upon the observations of those in attendance, always liable to be more or less erroneous, and in that it is not necessary to take a mean of a large number of diagrams: the examination of one set giving accurate results for the conditions which exist at the time they are taken.

The *Saranac* was completed in 1849. The engines were designed by C. W. Copeland, Esq., and built by Jabez Coney, of Boston. She originally had flue boilers of copper; but the great success of the *Martin Vertical Water Tube Boiler* led to their removal and the introduction of the latter type in 1857. Her engines, however, remain unchanged, except in the cut-off gear, which is quite unimportant in an economical point of view. The following are the dimensions of the vessel, boilers, and engines.—

HULL.—Length over all, 237 ft. Length between perpendiculars, 215 ft. Breadth, extreme, 38 ft. Depth of hold, 23 ft. 6 ins. Tonnage (Custom House measurement), 1440 tons. Draft of water at deep load, 17 ft. 9 ins. Displacement at above draft, 2290 tons. Area of midship section at above draft, 540 sq. ft. Speed in smooth water at sea with 393·5 horses power, 7 knots.

BOILERS.—Kind—Martin's patent vertical water tube; brass tubes. Number of pieces, two. Length of each, 10 ft. 6 ins. Breadth of each, 20 ft. 5 ins. Height of each, exclusive of steam drum, 11 ft. 3 ins. Do., inclusive of do., 13 ft. 3 ins. Number of tubes, 2860. Diameter of do., inside, 1 8-10 ins., outside, 2 ins. Length of do., 2 ft. 9 ins. Number of furnaces, 12. Length of grate bars, 6 ft. Breadth of each furnace, 2 ft. 9½ ins. Grate surface, 201 sq. ft. Fire surface, 6009 sq. ft. Ratio of fire to grate surface, 30 to 1. Diameter of smoke-pipe, 6 ft. 4 ins. Height of do. above grate, 60 ft. Air space through fire-bars, about 80 sq. ft. Do. through tube boxes, 27·5 sq. ft. Do. through smoke-pipe, 31·5 sq. ft.

ENGINES.—Kind—Inclined direct-acting. Number of cylinders, two. Diameter of do., 60 ins. Length of stroke, 9 ft. Condenser, common jet. Air pump. Inclined piston pump.

PADDLE WHEELS.—Kind—Common radial; wooden floats. Diameter over floats, 27 ft. 6 ins. Length of floats, 9 ft. Breadth of do., 2 ft. 6 ins. Number of do. in each wheel, 22. Immersion at above draft, 6 ft. 4 ins.

The cylinders of the *Saranac* are well surrounded by felt and wooden lagging, but there are no steam jackets; neither is the steam superheated.

The following are the observed conditions at the time the diagrams in the adjoining plate were taken. The engines of the *Valparaiso* differ from the others in not having the cylinders surrounded with steam, except in the cylinder bottoms of large cylinders, and in all cylinder covers. These diagrams were taken from the engines when doing their ordinary every-day work; it being the rule, both in our navy and in that line of steamers, to take one complete set each day, and place them on file. One-half only of each set examined are given in the plate.

The curved lines drawn upon the diagrams, marked M, show the true expansion curve, according to the law of MARIOTTE. Those

marked R in the diagrams from the *Saranac*, show the modification of MARIOTTE'S law, which is effected by the slight superheating of the steam during expansion, according to the laws of steam as given by REGNAULT. The dotted lines along the expansion curves of the diagrams, represent the true pressure in the cylinder.

	SARANAC.	VALPARAISO.	CALLAO.
Pressure of steam in the boilers, .	12 lbs.	$19\frac{1}{2}$ lbs.	18 lbs.
Vacuum in the condenser, .	26 ins.	26 ins.	26 ins.
Position of throttle valve, . .	Wide open.	4 ins. open.	
Temperature of hot-wells, .	110° F.		
Pounds of coal used per hour, .	1470	2240	1960
Kind of coal, . .	Anthracite.	Scotch, Welsh, & patent fuel.	
Per centum of ashes and clinker, .	21	15	15

When the induction valve is closed and the pressure suddenly commences to fall, the indicator piston is a little behind-hand in its movements, and then when it does start, its momentum carries it a little too far. In applying the dotted line, I have been compelled to rely entirely upon my experience and judgment in such matters. If any engineer thinks they are incorrect, he can easily retrace them to suit himself, and modify my results accordingly.

a	*b*	*c*	*d*	*f*	*g*	*h*	*k*
Part of Stroke.	Pressure by MARIOTTE'S Law.	Corresponding Temperature.	Corresponding total heat required to maintain the pressure in column *b*.	Total heat actually in the steam.	Difference available for superheating the steam, *f*—*d*.	Increase of pressure due to this superheating.	Consequent actual pressure, *b*+*h*.
DIAGRAM No. 1.							
	lbs. sq. in.	F °.	F °.	F °.	F °.	lbs. sq. in.	lbs. sq. in.
Commencement,	25·	241·	1187·47	1187·47	0·	0·	25·
$\frac{1}{8}$	25·	241·	1187·47	1187·47	0·	0·	25·
A $\frac{1}{4}$	22·	233·8	1185·16	1187·47	2·31	0·125	22·125
$\frac{3}{8}$	14·666	211.89	1178·61	1187·47	8·86	0·264	14·930
$\frac{1}{2}$	11·	197·54	1174·03	1187·47	13·44	0·301	11·301
$\frac{5}{8}$	8·8	187·39	1170·67	1187·47	16·80	0·301	9·101
$\frac{3}{4}$	7·333	175·57	1168·53	1187·47	18·94	0·283	7·616
$\frac{7}{8}$	6·285	172·63	1166·39	1187·47	21·80	0·279	6·564
End,	5·5	168·1	1165·17	1187·47	22·30	0·250	5·750
DIAGRAM No. 2.							
Commencement,	26·25	243·85	1188·32	1188·32	0·	0·	26·25
$\frac{1}{8}$	26·25	243·85	1188·32	1188·32	0·	0·	26·25
$\frac{1}{4}$	26·25	243·85	1188·32	1188·32	0·	0·	26·25
A 5-16	25·625	......	......	......	......	......	......
$\frac{3}{8}$	21·354	232·12	1184·74	1188·32	3·58	0·155	21·509
$\frac{1}{2}$	16·015	216·30	1179·92	1188·32	8·40	0·273	16·288
$\frac{5}{8}$	12·812	205·	1176·47	1188·32	11·85	0·309	13·121
$\frac{3}{4}$	10·677	196·13	1173·77	1188·32	14·55	0·316	10·993
$\frac{7}{8}$	9·152	189·74	1171·82	1188·32	16·50	0·307	9·459
End,	8·008	183·2	1169·82	1188·32	18·50	0·301	8·309

To obtain the expansion curve of MARIOTTE, the pressure was measured on the diagram at A and the calculations are made as if the stroke commenced at the line B; the space between that and the commencement of the diagram being the length of the cylinder which would be equal in capacity to the clearance between the valves and the piston at the end of the stroke. It will be observed that the measurement of the pressure at A for a *point d'appui* of the expansion curve is exactly

what is effected by the correction of the line traced by the indicator shown by the dotted line.

As I have observed in a recent publication that REGNAULT'S expositions of the laws of steam are sometimes misunderstood, I give in the foregoing table the exact method by which REGNAULT'S curve of expansion has been found in the two diagrams from the *Saranac* given in the plate.

The temperatures in column *c* were taken from the well known table of the pressures and temperatures of steam given in all engineering pocket-books. Where the pressures in column *b* were not found exactly in the table, the increase of temperature between the next higher and next lower tabular pressure was assumed to be proportional to the increase of pressure, which is not rigorously true, but is nearly so, for the small differences employed. The total heat required to maintain the pressure, column *d*, was taken from REGNAULT'S tables. Where the temperature in column *c* were not found exactly in the table the difference was obtained between the given and the next lower tabular temperature, and this multiplied by 0·305 gave accurately the amount which was required to be added to the tabular total heat. The increase of pressure was obtained upon the rule of REGNAULT that it was doubled by the addition of 494° Fahr.

From this table it would appear that where the heat of the steam is neither increased nor diminished by extraneous influences, any expansion of the steam causes it to be superheated and not condensed, as some have erroneously asserted, basing their assertion upon the laws of steam as given by REGNAULT.

A little reflection must also convince any one not carried away by a kind of scientific fanaticism that the yielding of the piston in the cylinder to the pressure upon it affects the steam only by giving it an opportunity to expand. What then becomes of Prof. JOULE'S theory that condensation is caused by a rendition of power on the part of the steam? It is painful to know that such absurd doctrines are advanced by men of learning and position, and that they are proved to be correct, and adopted into the calculations of others equally learned and high in position.

In the subjoined tables will be found the calculations of the diagrams from the engines of the three vessels compared, tabulated in such a way as to enable any engineer to judge of the correctness of the results obtained and to insert his own corrections at the proper point wherever he may consider it necessary.

In obtaining the amount of steam condensed in the cylinders of the *Saranac* before the point of cutting off, I was necessarily compelled to assume that the cylinder remained constantly at the same temperature during the different fluctuations of the steam within it—as to attempt a calculation of the amount of its fluctuations during the stroke would be a refinement which I consider is much better left out of all investigations of this kind. If it could be accurately known and employed the result of the calculation would be a greater amount of condensation previous to cutting off than has been arrived at in the table. Because, when the steam first entered the cylinder the temperature of

the latter is below the mean, but when the piston is at the commencement of the ¼ stroke which has been taken for a measure of the condensation, the metallic surfaces with which the steam is in contact has been heated to a temperature above the mean, and during this ¼ stroke its temperature is still going up, so that the difference between the temperatures of the steam and the surfaces with which it is in contact is not so great during the above ¼ stroke as between the steam and the mean temperature of the cylinder given in the table. The condensation per unit of surface and unit of difference in temperature is, therefore, greater than that arrived at in the table. At the same time the difference between the temperatures of the steam and the surfaces with which it comes in contact before cutting off is greater than between the steam and the mean temperature of the cylinder, so that this greater condensation per unit should be multiplied by a greater difference of temperature than is given in the table.

In calculating the condensation of the different diagrams the unit in the fifth column only was used.

One-fourth only of the stroke was used to find the unit for calculating the condensation and that taken immediately after the starting point of the expansion curve of the diagrams, because during the latter part of the stroke the temperature of the steam gets below that of the cylinder and the condensation not only ceases but evaporation takes place, which is not only very reasonable, but may be observed in the diagrams of the *Saranac* given in the plate, while during the ¼ stroke made use of the temperature of the steam was always above that of the linder.

The loss by blowing off has been taken at about the average of sea-going ships when the existence of scale is ignored, and the same for all. It is put into the account of the engines because it is an attachment of the engines and not of the boilers which prevents this loss.

In computing the number of times the steam is expanded the ratio is found between the space filled with steam at the point of cutting off and the space filled at the end of the stroke. The steam really expands as much more than this as there is condensation beyond the point of cutting off. That is, however, a kind of expansion that requires no "precedents" to prove it unbeneficial.

In calculating the diagrams of the *Valparaiso* and *Callao* I labored under the difficulty of not knowing the amount of space in the clearances of the piston and the steam passages. I estimated this amount for the small cylinders to be equal to 3½ inches in length of cylinder for the upper end and 4 inches for the lower end. This may appear large until it is remembered that these cylinders have, not only the ordinary induction passages, but in addition there are the peculiar eduction passages to the large cylinders, within which, as in a steam chest, are the slide valves of the large cylinders. With regard to the clearances in the large cylinders I was guided entirely by the amount which the pressure of the steam fell at the end of the stroke of the small piston and the commencement of the stroke of the large piston, as shown by the diagrams accounting the spaces filled to be inversely as the pressures indicated.

TABLE *showing the Method employed and Results obtained in Calculating the Economy of the Engines of the Saranac.*

	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagrams combined.
Pressure in pounds per square inch of the steam in the cylinder at the point of cutting off,	25·	26·25	24·5	23·6	
Cubic fe ' and clearances filled with steam of the above pressure,	41·0366	67·2676	43·2946	65·9589	
Number by the engines per minute,	12·	12·	11 5	11·	
Relative steam of the above pressure and water,	1044·	1015·	1004·	1101·	
Pounds of water in the form of steam of the above pressure, at the time of cutting off, per hour,	1768·8	2580·	1754·75	2081·4	8184·95
Total heat in saturated steam of the above pressure, F.°	1187·47	1188·32	1187·11	1186·36	
do do atmospheric pressure, F.°	1178·6	1178·6	1178·6	1178·6	
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,	13·2	21·	11·75	13·6	59·55
Mean temperature of steam during the full stroke of the piston, F.°	200·	211·19	196·96	200·4	
do do forming the back pressure during the return stroke of the piston, F.°	142·64	153·24	144·41	140·4	
Consequent mean temperature of the cylinder, F.°	176·76	176·76	172·04	172·04	
Mean temperature of the steam during the ¼ stroke of piston next after the point A of the diagrams, F.°	209·8	221·4	213·	215·2	
Difference between temperature of steam and mean temperature of cylinder during the above ¼ stroke, F.°	33·04	44·64	40·96	43·16	
Number of pounds weight of steam condensed per hour in the above ¼ stroke,	291·1	300·	248·5	240·2	
Number of square feet of surface in contact with the steam at the commencement of the above ¼ stroke,	92·49	105·77	92·49	105·77	
do do do do end do do	129·77	143·06	129·77	143·05	
Mean do do do during do do	111·13	124·41	111·13	124·41	
Fraction of complete revolution made by the engine do do do	·094	·080	·094	·080	
Number of pounds weight of steam condensed per hour per unit of surface and unit of difference in temperature	·8434	·6069	·5807	·5026	·6334
Difference between temperature of steam and mean temperature of cylinder before the point of cutting off, F.°	64·24	67·09	67·86	65·7	
Mean number of square feet of surface in contact with the steam before cutting off,	82 61	42·75	86·96	42·	
Fraction of complete revolution made by the engine from the commencement of the stroke until steam is cut-off,	·14	·1722	·1444	·17	
Number of pounds weight of steam condensed in the cylinder before cutting off, to be added to the evaporation given above,	185·19	312·63	229·38	297·13	1024·63
Number of pounds weight of steam which represent 12 per cent. loss by blowing off to keep the saturation down in the boilers,	268·26	397·34	272·16	326·2	1263·96
Total number of pounds weight of steam which represent the heat expended upon the engines per hour in obtaining the power,	2236·44	3311·17	2268·04	2718·33	10532·06
Number of times the steam is expanded in the cylinder,	4·64	3·29	4·3	3·35	3·70
Mean effective pressure on the piston in pounds per square inch,	9·6	13·52	9·7	11·	
do d d been no condensation in cylinder after steam was cut off,	10·39	14·72	10·66	12·3	
Consequent per c condensation in cylinder after steam was cut off,	7·62	8·15	9·	9·63	8·63
Per centume of t fensed in the cylinder before cutting off,	9·41	10·73	11·49	12·42	11·05
Total per centume of loss by condensation in the cylinder,	16·93	18·88	20·49	22·25	19·68
Mean back pressure on the piston in pounds per square inch,	2·8	3·52	2·88	3·07	3·06
Per centume of loss of useful effect by back pressure,	22·58	20·66	22·70	21·64	21·94
Horses power developed upon the piston,	89·1	12·61	86·	93·3	393·6
Number of pounds weight of steam which represent the heat expended upon the engines per hour per H. P.	25·089	26·408	26·372	29·185	26·767

TABLE *showing the Method employed and the Results obtained in Calculating the Economy of the Engines of the Pacific Steam Nav. Co.'s Steamers,*

Pressure in pounds per square inch of the steam in the small cylinder previous to cutting off,										
Cubic feet of space in small cylinder and clearances filled with steam of the above pressure,										
Number of revolutions made by the engine per minute,										
Relative volume of saturated steam of the above pressure and water,										
Pounds of water in the form of steam of the above pressure at the time of cutting off, per hour,										
Total heat in saturated steam of the above pressure, F.°										
do do atmospheric pressure, F.°										
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,										
...nts of cylinders, allow-										
...nts of cylinders, allow-										
...ent. loss by blowing off										
...he heat expended upon										
...stroke of large piston,										
Mean effective pressure on small piston in pounds per square inch,										
do back do do do										
Per centums of loss of useful effect by back pressure on small piston,										
Mean effective...										
do back...										
Per centums ...	40·7	53·7	49·	53·7	39·	40·8	33·6	40·9	39·5	33·96
do ...combined,	34·9	33·1	41·23	33·1		36·3	29·7	30·35	33·4	
Pressure in pounds per square inch on small piston, which it is assumed would overcome the friction of itself and its immediate connexions,	1·25	1·25	1·25	1·25		1·25	1·25	1·25	1·25	
Horses power developed upon the small piston,	100·58	122·46	97·3	122·46	442·75	94·118	104·942	104·628	95·216	398·904
do do after the above friction is deducted,	92·29	114·42	89·06	114·42	410·19	86·245	97·069	96·755	87·343	367·412
do do large piston,	67·18	44·72	66·	44·72	222·62	68·135	69·075	76·	61·185	274·395
Total horses power, with the extra friction, inherent to double cylinder engines, deducted,	159·47	159·14	155·06	159·14	632·81	154·38	166·144	172·756	148·528	641·807
Number of pounds weight of steam which represent the heat expended upon the engines per hour, per horse power,	16·117	22·901	16·963	22·901	19·737	23·301	18·606	18·673	19·304	20·25

The clearances of the *Saranac* are equal to 6 inches length of cylinder at the upper end and 6·8 inches at the lower end.

In obtaining the weight of the water evaporated from the diagrams of the *Valparaiso* and *Callao* I have treated it as though saturated steam was used; this gives a slight excess of the true amount of even that which would be evaporated by the heat contained in it, but the error is very small, and could not be corrected because the exact amount which the steam was superheated at the time the diagrams were taken is not noted on them, and I am informed that it varies considerably at different times.

It is estimated by English engineers familiar with the steam jacket, that five per cent. of the steam raised in the boiler is condensed in the jacket. This amount appears rather small when the great number of expansions are considered, but it must not be forgotten that the steam is superheated both when entering the cylinder and the jacket. Mr. Jameson was intending to ascertain by direct experiment how much was thus condensed, but when I left the Pacific it had not yet been done. The bottoms of the large cylinders and all cylinder covers being the only steam jackets around the cylinders of the *Valparaiso* amount to 38·8 per cent. of their whole surface, and 5 per cent. of this is (38·8 × ·05 =) 1·94 per cent.

Collecting the data contained in the foregoing we have the following results and comparisons between the engines *per se*, the boilers *per se*, and of them both combined.

	Saranac.	Valparaiso.	Callao.	Mean between Valparaiso and Callao.
Actual Performances.				
Pounds of steam required per hour per H. P.,	26.767	19·735	20·25	19·993
Pounds of water evaporated per lb. of coal,	7.165	5·575	6·631	6·103
" " per lb. of combustible, . . .	9·070	6·597	7·807	7·202
Pounds of coal required per hour per H. P.,	3·735	3·540	3·054	3·297
" combustible " "	2·911	3·010	2·596	2·803
Relative Performances.				
Ratio of power obtained per unit of water evaporated, . .	1·000	1·356	1·321	1·338
Ratio of water evaporated per unit of coal consumed, . . .	1·000	0·778	0·922	0·850
Ratio of water evaporated per unit of combustible consumed, .	1·000	0·728	0·860	0·793
Ratio of power obtained per unit of coal consumed, . .	1·000	1·055	1·223	1·139
Ratio of power obtained per unit of combustible consumed, .	1·000	0·967	1·121	1·044

From this exhibit it would appear that there is no doubt about the superiority of the *engines* of the *Valparaiso* and *Callao* over those of the *Saranac*, but in comparing the two sister vessels together we get the best results from the engines which are only partially steam jacketed, but it is evident from the appearance of the diagram from the top end of the cylinder (*Valparaiso* No. 1) that the induction valve leaked, and the evaporation given in the tables is therefore deficient to the extent of the leak.

As the same coals were used in both vessels the true evaporation per pound of coal is very probably nearly the same.

The ratio of excellence of the *engines* of the two vessels, as per the above table, stands:

Valparaiso 1·000; *Callao* 0·974.

But if the same amount of water is really evaporated by the boilers of each, the ratios would stand:

Valparaiso 1·000; *Callao* 1·154.

They would then compare with the *Saranac* as follows:

Saranac 1·000; *Valparaiso* 1·138; *Callao* 1·321.

It is evident from the tables that a much greater economy could be obtained from these engines by simply increasing the pressure, so that the per cent. of loss by the back pressure in the large cylinder would be reduced. In the *Valparaiso* this is now 49·1 and in the *Callao* 38·6. To double the pressure would reduce this loss one-half. This could be done without much increasing the pressure in the boilers by permitting the steam to follow the small piston farther. It will be observed that the horses power of the small cylinders is the greatest in each case; if, therefore, they were to follow the small piston far enough to make the power of the large piston a little the greatest it would of itself reduce the above loss considerably, while the loss by the diminished number of times the steam would be expanded, would be comparatively very small.

Report of the Committee on Gas Works, presented to the Select and Common Councils of the City of Philadelphia, April 19, 1860.

To the Select and Common Councils of the City of Philadelphia.

The Committee on Gas Works, to whom were referred the following resolutions, viz:

"*Resolved*, By the Select and Common Councils of the City of Philadelphia, that the Committee on Gas Works be instructed to inquire and report whether the manufacture of gas from any materials other than those now in use at the Philadelphia Gas Works, is practicable; and if so, whether such gas can be manufactured at a cheaper rate than is now charged, and if so, at what rate; and whether such gas gives an equal or greater degree of light than that manufactured from coal; and if thought practicable, what cost will be incurred in change of apparatus, &c., and any other information relative to the subject, which they may deem important.

"*Resolved*, That they be further instructed to inquire and report from what cause (if it can be ascertained,) the bills of consumers of gas have been, of late, so largely increased; whether from defective meters, or from inferior quality of gas furnished, or from other causes.

"*Resolved*, That the Committee be instructed to report at as early a day as convenient."

Respectfully report—That, in reference to the first resolution, the Committee are not, as yet, prepared to report.

In pursuance of the second resolution, directing inquiry into the cause of the recent increase in the amount of gas bills, it seemed right for the Committee first to ascertain whether the increase referred to, had any existence, in fact.

For this purpose, a statement has been compiled from the Bill Books of the Gas Offices, exhibiting all the bills issued in the months of December, January, and February, during four successive years, to all consumers, who, for that time, have continued to use gas in the same premises, in the wards comprising the old city proper, Moyamensing, Spring Garden, Penn Township, and West Philadelphia.

This statement comprises the bills of 11,114 consumers, to whom more than 44,000 bills were issued during the four winters.

It appears that the bills of 3259 of the consumers, or not quite one-third, are higher in the last winter than in those of the three previous years, and the bills of 7855, or rather more than two-thirds, are not higher than those for previous years.

The aggregate amount of all the bills to these consumers, in the winter of

1856–57	was	$138,177·70
1857–58	"	125,762·24
1858–59	"	137,923·36
1859–60	"	141,368·54

the increase of 1859–60, over 1856–57, being $3190·84, or about 2¼ per cent.

The reports of the Inspectors of fittings show that in the interval between 1856 and 1859, the number of additional lights, put on by the consumers included in the foregoing statements, is 8300, or about 6 per cent. increase of lights, if these customers are supposed to have in use the average number of lights, which is shown by the published reports to be twelve to each consumer.

From this it appears, that the amount of gas used has not increased as much as the number of lights in use; and a similar result is exhibited by comparing the whole quantity of gas sold in the year with the whole number of lights in use at the beginning of the year. For example, the number of lights reported to Councils, as in use in January, 1856, was 300,406, and the cubic feet of gas sold in that year was 415,888,950, being 1384 feet to each light. The lights reported in use in January, 1859, was 378,462, and the cubic feet of gas sold in that year was 494,128,345, being 1305 feet to each light, or 5¾ per cent. less than before.

These comparisons have been carried back so as to include four years in order to avoid the erroneous conclusions which would result from taking only the past two years, which included a period of commercial depression, the effects of which are very marked upon the consumption of gas by certain classes of consumers; among whom the various manufacturers present very conspicuous examples; while among other classes not thus affected by business, the quantity of gas consumed has been curiously regular, sometimes the bills for three

or four successive winters not materially varying in amount, and in thousands of instances not differing so much as one dollar for several years. The aggregate amount of the bills for the periods of commercial distress, and also the average consumption per light in use, are shown to be diminished in a remarkable degree, and gives strong confirmation to the other proofs elicited by this laborious investigation, of the carefulness and accuracy with which the books and accounts of the City Gas Trust are kept.

The table of annual consumption per light, compiled from the published reports to Councils, shows the average amount of gas used per light to be less in 1859 than in any other of the eighteen years elapsed since the City has owned the Gas Works, except 1857 and 1858, when the consumption was so much reduced by the suspension of business.

In addition to the statements exhibiting the foregoing facts, relating only to consumers who have been supplied during four successive years, two others have been prepared, embracing all those consumers who have used gas during the last two winters, in Southwark and Kensington.

These comprise two bills for each of 3408 consumers, amounting to 6816 bills, and make an aggregate of more than 50,000 bills, whose amounts, making a total of $543,231·84, have been examined and compared in this investigation.

In the first named district the gas was derived from the City Works during both winters; but in the former season, received only an inadequate supply, in consequence of the imperfect communication between the local main of the Southwark Gas Company, and those of the City, from which the supply was drawn; which defects were removed in the summer of 1859.

The aggregate of the bills here, on the 1st of March, 1859, was $10,652·79, and in March, 1860, was $11,683·24, the increase being $1030·45, or not quite 10 per cent.

In Kensington, the bills rendered by the Northern Liberties Gas Company, on the first of April, 1859, amounted to $12,573·42; and those by the City Gas Works, to the same consumers for the corresponding period in 1860, amount to $10,224·74, the former amount being greater by $2348·68, or 22 per cent. over the latter.

Part of this gain to the people of Kensington, results from the lower price now paid per one thousand cubic feet; but the books show that nearly one-half of it is in the saving of gas consumed, which is nearly 10 per cent. less since their supply from the City Works. It is proper to remark, in this connexion, that the saving to the City of cost of gas for public lighting, by the purchase of the Kensington Gas Works, is about $5000 a year; while the quantity of light in the streets is generally greater since the change in the souree of the supply.

In Southwark, out of 1618 bills rendered, 1029 were larger in 1860, than in 1859, and 589 were not larger.

In Kensington, out of 1790 bills rendered, 378 bills were larger in 1860, than in 1859, and 1412 were not larger.

The unavoidable conclusion to which the Committee has arrived,

after a careful consideration of the foregoing facts, is that there has been no general increase in the amount of gas bills, nor any local increase that is not evidently the result of an increased facility of supply; and moreover, that an examination of the accounts of the many thousands of gas consumers kept in the offices of the City gas trust will satisfy every unbiased mind as to the regularity and reliability of the records of consumption given by the instruments used for the measurement of gas.

The voluminous statements compiled from the bill books for the use of the Committee are kept open to the inspection of any member of Councils, and indeed of any citizen, who may desire to examine them, and thus form his own judgment as to the accuracy of the statistics that have been derived from their critical analysis.

WM. ROTCH WISTER, WILSON KERR, J. E. ELDRIDGE, GEORGE READ,	*Committee on Gas Works.*	CHARLES T. JONES, WM. BRADFORD, O. H. P. PARKER, STEPHEN BENTON,

Philadelphia, April 19th, 1860.

RECAPITULATION.

CITY.

First Section. North of the North Side of Market Street, from Delaware to Schuylkill, due February 1,

1857	1858	1859	1860
$34,115·70	$30,262·73	$34,286·45	$34,516·75

Second Section. From North Side of Market Street to South Side of Walnut Street (inclusive) from Delaware to Schuylkill Rivers, due December 1,

1856	1857	1858	1859
$29,554·60	$26,319·92	$28,617·36	$30,253·20

Third Section. South of the South Side of Walnut Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due January 1,

1857	1858	1859	1860
$31,306·77	$29,674·85	$32,487·00	$32,040·10

Monthlies. From Vine Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due

	1856–7	1857–8	1858–9	1859–60.
December 1,	$4483·64	$4107·41	$4729·48	$4670·58
January 1,	4438·14	4882·41	4728·81	4849·50
February 1,	5380·71	4245·81	4446·30	4690 25
Total,	$14.302·49	$13,235·63	$13,904 59	$14,210·33

SPRING GARDEN.

First Section. East of Twelfth Street and North of Vine Street, all Streets running North and South, due December 1,

1856	1857	1858	1859
$5977·56	$5728·48	$6131·75	$6711 95

Second Section. East of Twelfth Street, and North of Vine Street, all Streets running East and West, due January 1,

1857	1858	1859	1860
$6916 86	$6532·86	$7113·91	$7378·35

Third Section. West of Twelfth Street, all Streets North of Vine Street, due February 1,

1857	1858	1859	1860
$8554·41	$6903·45	$8300·76	$8929·51

Monthlies. North of Vine Street, from Sixth Street, &c., to Schuylkill River, due

	1856–7	1857–8	1858–9	1859–60
December 1,	$503·97	$474·73	$517·26	$551·25
January 1,	675·04	654·32	613·35	619·43
February 1,	552·35	559·36	567·21	604·47
Total,	$1731·36	$1688·41	$1697·82	$1775·15

MOYAMENSING.

Due, Dec. 1st,

1857	1858	1859	1860
$4251·89	$4036·38	$3970·95	$4104·00

WEST PHILADELPHIA.

Due,	1857	1858	1859	1860
January 1,	$919·33	$879·80	$872·82	$901·82
February 1,	546·73	508·73	539·95	547·38
	1466·06	1383·53	1412·77	1449·20
Total,	$138,177·70	$125,762·24	$137,923 36	$141,368·54
	Grand Total, .		$543,231·84	

KENSINGTON.

Due, April 1st,

1859	1860	1859	1860
$12,573·42	10,224·74 cubic feet 5,029,370		cubic feet 4,544,328

or about 22 per cent. more in 1859 than in 1860.

378 bills greater in 1860 than in 1859.
1403 " less " "
9 " identical " with "

Total, 1790 Bills.

SOUTHWARK.

Due, March 1st,

1859	1860
$10,652·79	$11,683·24

1029 bills greater in 1860 than in 1859.
473 " less " "
116 " identical " with "

Total, 1618 Bills.

SUMMARY.

Showing the proportion of bills in the last winter, that are greater, or less, or identical with those of previous years.

	Greater.	Less.	Identical.	Total.
Old City Proper,	1979	4550	851	7380
Spring Garden,	1070	1401	491	2962
Moyamensing,	164	331	101	596
West Philadelphia,	46	101	29	176
Total, .	3259	6383	1472	11,114

Number of instances of Identical Bills in the four years.

	2 Bills.	3 Bills.	4 Bills.
Old City Proper,	1559	88	43
Spring Garden,	822	55	39
Moyamensing,	169	9	13
West Philadelphia,	45	5	2
Total, . .	2595	157	97

Year.	Lights in use January 1st.	Gas sold during the year.	Cubic feet per light.
1842	24,996	49,888,830	1995
1843	28,080	47,565,751	1693
1844	31,557	53,631,156	1699
1845	36,682	54,076,598	1746
1846	42,558	74,547,300	1751
1847	50,792	89,700,993	1766
1848	66,822	105,663,050	1581
1849	84,523	134,003,850	1583
1850	110,591	181,267,500	1639
1851	129,027	195,212,325	1517
1852	143,441	209,574,250	1461
1853	168,381	248,120,995	1473
1854	200,848	279,307,174	1340
1855	222,989	293,800,915	1313
1856	300,406	415,888,950	1384
1857	338,592	432,052,884	1276
1858	357,729	444,631,979	1242
1859	378,462	494,128,345	1305

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*On the Efficiency of various kinds of Railway Brakes; with Experimental Researches on their Retarding Powers.** By Mr. W. Fairbairn, M. Inst. C. E.

The present communication was based upon an inquiry which arose out of a report prepared by Col. Yolland, R. E., for the Railway Department of the Board of Trade. That report gave the results of a large number of experiments, with heavy trains at high velocities, made with the steam brake of Mr. McConnell, the continuous brake of Mr. Fay, the continuous and self-acting brake of Mr. Newall, and the self-acting brake of M. Guérin. The conclusions arrived at being favorable to the brake of Mr. Newall, as well as, partially, to that of M. Guérin, for some descriptions of heavy traffic, Mr. Fay made application to the directors of the Lancashire and Yorkshire Railway, for a further investigation of the subject. This permission was granted, and the author agreed to arrange the conditions of the trial, and to superintend the experiments.

*From Newton's London Journal, May, 1860.

The objects the author had in view were—first, to ascertain the respective retarding power of each of the competitive brakes; and, secondly, to obtain some data in regard to the rapidity with which a train, with an engine and tender attached, could be brought to a stand, when traveling at a high rate of speed; so as to determine the value of the continuous and self-acting brakes, as compared with those ordinarily in use, and with others recently introduced. To enable this comparison to be made, the experiments were reduced to a common standard, by means of a few dynamical laws, which were explained.

It was stated that, in the increase of the braking power of trains, the principles hitherto most successfully employed, had been,—first, the use of steam acting direct on the brakes; second, the connexion of several of the ordinary form of brakes, so as to have them under the control of a single brakesman; and, third, the introduction of braking apparatus connected with the buffers, so as to make the momentum of the train itself available in generating a retarding force.

A description was then given of the different brakes before alluded to as having been experimented upon by Colonel Yolland. It was mentioned, that Mr. Newall claimed the earlier application of a combination of brakes, acted upon by one guard through a longitudinal shaft; and that Mr. Fay had adopted the same principle, with very slight modification, either in form or in construction.

The mode of carrying out the experiments with Mr. Newall's and Mr. Fay's continuous brakes was then detailed, and the results obtained were recorded in seven tables, one for each set of trials. As, in the reductions, the value of the retarding force of the brakes was found in terms of the co-efficient of friction of the rubbing surfaces, the efficiency of the brake varied with the condition of the weather. Thus, the mean of the Oldham experiments gave a retarding force of 1·7987 feet per second; the mean of the first experiments at Southport 4·2978, and of the second 3·3245. On each day the experiments were consistent with one another, but they varied greatly, on different days, from the change in the condition of the rubbing surfaces. At Oldham, the experiments were made with the rails in a greasy condition from fog; at Southport, in the first trial (Table 2), with the rails dry, and in the best state for braking, and in the second (Table 3), with the rails slightly wet. These results were in accordance with the experiments of Morin, on the friction of iron on iron, from which it was found that the co-efficient of friction varied from 0·05 to 0·3, according as the surfaces were greasy, wet, or dry. The remaining experiments were all made under the most uniform and favorable conditions. They were, therefore, grouped together under the following heads:—

1. On the friction of the carriages (Table 4).
2. With slide brakes, and the engine detached (Table 5).
3. With flap brakes, and the engine detached (Table 6).
4. With the engine attached to the train (Table 7).

The following table gave a brief summary of all the experiments except those on the friction of the carriages, which was found to

amount to 11·527 lbs. per ton weight of train in Mr. Fay's case, and to 7·627 lbs. per ton in that of Mr. Newall:—

	No. of Experiments.		Average efficiency of Brake.	
	Mr. Fay.	Mr. Newall.	Mr. Fay.	Mr. Newall.
Oldham Incline, Table 1,	7	7	1·8538	1·7136
Southport " " 2,	5	1	3·6256	4·9700
" " " 3,	1	1	3·2329	3·4161
" " " 5,	8	8	6·7030	5·4984
" " " 6,	3	3	5·8718	6·3272
" " " 7,	3	3	3·0934	3·0250

The general average from this table gave, for the efficiency of Mr. Fay's brake, 4·0634, and for Mr. Newall's, 4·1650, showing a slight superiority in favor of the latter. The following conclusions seemed to be borne out by the experiments:—1. That with slide brakes, the greater number of experiments gave a manifest superiority to Mr. Fay. 2. That with flap brakes, there was a decided advantage on the side of Mr. Newall. 3. That when the train was braked, with the engine attached, the results were uniform, neither gaining any decided superiority.

Colonel Yolland's experiments were then tabulated, and reduced in the same manner as the author's, so as to admit of comparison with them. The results thus arrived at, in reference to two of the systems, were exhibited in the annexed summary:—

	Mr. Newall.	Mr. Fay.	Remarks.
Engine Detached,	3·5516 3·017	3·9345 3·255	Dry. Wet.
Engine Attached,	4 671 5 146 4·505	......	Mean 4·774.

The final reduction of the retarding force, to units of weight of the brake carriages, was given in the following general summary:—

Brake.	Weather.	Experimenters.	Ratio of Weight on the Brakes to the Retarding Force generated by them, or the Mean Co-efficient for each Brake.
Mr. Newall's,	Dry.	Fairbairn.	From 0·1544 to 0·1965
"	Wet.		0·0542
Mr. Fay's,	Dry.		From 0·1126 to 0·2082
"	Wet.		0 0576
Mr. Newall's,	Dry.	Yolland.	From 0·1116
Mr. Fay's,	Dry.		0·1020
Mr. Ingram's,	Wet.		0 1075
M. Guérin's,	Dry.		0·01048
Mr. McConnell's,			02·8325

Showing that the retarding force varied from the one-hundredth to five-eighteenths of the weight of the carriages to which brakes were applied, and was ordinarily from one-tenth to one-fifth.—*Proc. Inst. Civ. Eng.* April 17, 1860.

MECHANICS, PHYSICS, AND CHEMISTRY.

*On Platinum and its associated Metals.** By MM. DEVILLE and H. DEBRAY.

The *Annales de Chimie et de Physique* for August last contains a very elaborate article by the above chemists on the subject of platinum and the metals which accompany it. The results at which they have arrived are so important, and they are moreover of such interest, that we are induced to lay before our readers a few of the principal facts contained in their memoir.

The metallurgy of platinum is altogether a modern art, the introduction of the metal into the laboratories of science and industry dating but from a few years back; and although particularly deserving the attention of the chemist, the metallurgy of platinum and its congeners is, in general, but little known. Except for chemical purposes, platinum has not hitherto received any important application; but when we know better where to look for its ores, and when the deposits already known are more extensively worked, the ores of platinum will, perhaps, become no rarer than gold; and as the metal is almost indestructible, and as its value protects it from losses and accidents of all kinds, it must in time accumulate and thus become more plentiful. It may then perhaps be applied to other useful purposes in which its weight and slightly tarnished color will be no objection, or for which its absolute unalterability will give it a peculiar value. The solution of these questions, however, depends on the price for which the metal can be supplied; and the chemist is particularly interested in seeing its cost so far reduced that the large vessels of the laboratory may be made of platinum. It was in the hope of facilitating a progress of this kind, that MM. Deville and Debray undertook the difficult researches the results of which are given in the above-mentioned memoir, a work which has cost them more than four years of labor.

Until the first communications of M. Deville were published, no one dreamt of utilizing all the metals found with platinum, and with the exception of palladium and osmium, which there was always a motive for separating, platinum alone has been extracted from the ores, leaving a residue which has accumulated in all the manufactories in Europe as well as in the Russian Mint.

The processes described are exclusively by the dry way, and by fusion at a very high temperature. They are given in different chapters, which treat of "the revivification of pure platinum," "the metallurgy of pure platinum," "the extraction from the rough ore of a triple alloy of platinum, rhodium, and iridium of a suitable and invariable composition;" and lastly, the extraction, whether from the residues or from the osmide of iridium, of the utilizable metals, platinum, palladium, rhodium, and iridium.

We give first, the methods practised for obtaining pure platinum, reserving for a future occasion the interesting accounts of the indivi-

* From the Lond. Chemical News, No. 1.

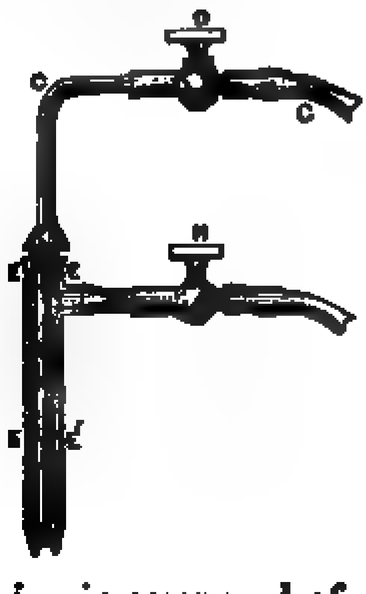
dual metals, and the methods for assaying the rough ores, metals, and residues.

In commerce, platinum is found which is almost free from iridium, but which still contains traces of osmium and a little silicium. MM. Deville and Debray have discovered that fusion in lime by means of an oxidizing flame, refines it perfectly, osmic acid being disengaged, and the silicium becoming converted into silicate of lime, which melts into a colorless bead, and moves rapidly about on the surface of the metal until it reaches the edge, where it is absorbed by the sides of the furnace. Platinum so melted and refined is a metal as *soft* as copper; it is whiter than ordinary platinum, and does not possess the porosity which has hitherto been an obstacle to the manufacture of an impermeable platinum sheath.

Melted platinum still possesses the property of condensing gases at its surface, and of producing the phenomenon of a lamp without flame. Its density = 21·15—less than the density of ordinary platinum which has been subjected in the working to a powerful hammering (*d'un écrouissage extrémement energique*).

We now proceed to describe the apparatus by means of which platinum has been melted, in quantities relatively considerable, and run into ingots, like a metal of ordinary fusibility.

The fuel most often employed has been common coal-gas, but hydrogen may be used, and when pure will give even a greater heat. The combustion is fed by a current of oxygen. The furnace in which the fusion is made, is of lime bound with iron wire. It is composed of two parts: 1, The roof A A, made of a cylindrical piece of lime slightly arched on its lower surface, and pierced by a conical hole Q, through which a blowpipe C E is to pass; and, 2, a bottom B, made of another piece of lime, hollowed as shown in the diagram. The hollow should be scooped out so deep, that the melted platinum may occupy a depth of 3 or 4 millimetres or more. At the anterior part D, a groove inclined a little towards the inside is made with a file, which is to serve as a hole for the metal to run out of and for the flame to issue from.



The blow-pipe is composed of a copper cylinder E E, terminated at its lower extremity by a slightly conical tube E′ E′, made of platinum.

A copper tube C C, having a platinum nozzle, enters the first cylinder at its upper extremity, and is so arranged as to allow the nozzle to be slid up or down, and placed at any height from the lower end of the cylinder E E E′ E′, that may be wished.

A stop-cock H, is attached to the side of the cylinder E, by means of a tube as large as the cylinder itself. Another stop-cock O, terminates the elbow of the tube C. It is by the stop-cock H, that the hydrogen or coal gas passes, and the oxygen is introduced through the stop-cock O.

When the fusion is to be made, the pieces of lime composing the furnace are put together in the way represented in the diagram. Then, holding the blow-pipe in the hand, the stop-cock H, is opened so as to allow the passage of a gentle stream of gas which is lighted, and the stop-cock O, is turned to admit the oxygen necessary for the combustion. The flame is in this way plunged into the apparatus by the hole Q, in such a manner as to avoid an explosion, which might disturb the pieces of lime. The body of the furnace is now gradually heated; the quantity of the gases passing being increased by degrees until the maximum temperature is attained. The degree of heat may be raised or lowered as need be, by raising or lowering the platinum nozzle which supplies the oxygen. The temperature is now lowered, and the platinum is introduced, by little and little, through the opening D. When it is in thin slips of less than a millemetre in thickness there is scarcely time to introduce them. They are seen to melt and disappear almost at the moment they enter the furnace. The oxygen should arrive at a regular pressure of about four or five centimetres of mercury, and ought to give a rotary movement to the platinum so as to equalize the temperature throughout the mass.

When it is not wished to run the metal into a mould, the fusion being perfect, and the refining completed, which is the case when no more vitreous matter is seen to form on the surface, the two gases are turned off by degrees, always leaving the oxygen in a decided but very slight excess. The mass now gradually solidifies, and the flame may be completely extinguished. A little of the metal is always thrown up to the roof of the furnace, where it may be easily collected after the operation is finished.

When the platinum is to be cast, an ingot mould is prepared of thick cast iron, well rubbed with plumbago, or of coke or lime. The last are most easily made of plates of the substance, sawn, and held together by iron wire. The roof of the furnace is taken off, the body seized with a pair of tongs, and the platinum is poured out, without hurrying, just as we should any other metal. The only difficulty which occurs, and this a little practice will enable the operator to overcome, is to discern at the same time the dazzling surface of the metal and open mouth of the mould, before turning up the crucible. A larger quantity than 3 or 4 kilogrammes should never be cast in this way, inasmuch as there would be great danger of some part of the apparatus giving way.

For greater quantities, the authors describe how a larger furnace

may be made of several pieces of lime bound firmly together with iron; an ingenious and simple arrangement, by means of which the metal may be poured out without taking up the bottom part of the apparatus. The reasons they give for preferring to use lime in the construction of the furnace are as follows:—

1. Lime is perhaps the worst conductor of heat known; so much so, that through a thickness of at most 2 centimetres (0·8 inch), the apparatus being full of melted platinum, the temperature of the outside is barely 120° (Cent.)

2. Lime radiates heat most perfectly. For this reason it is the best material for the sides of a reverberatory furnace of this kind.

3. Lime acts on all the impurities from which we wish to free platinum—iron, copper, silicium, &c., changing them into fusible compounds, which are absorbed by its porous substance. It acts like a cupel, the material purifying the metal melted in it.

An experiment made in the laboratory of the *Ecole Normale* showed that the quantity of oxygen required to melt 1 kilogramme (2·2 lbs. Avoird.) of platinum was only 60 litres (about 13 gallons), the cost of which was estimated at 0·4 of a franc. The cost of the coal gas or hydrogen used was not considered worth taking into account.

The process applied to the revivification of old platinum gives excellent results. No foreign metal except iridium and rhodium can exist in platinum after it has been melted and refined in the method described. All the substances which most easily attack platinum, sulphur, phosphorus, arsenic, gold, soda, iron, copper, palladium, and osmium, are separated either by oxydation and absorption by the lime or by volatilization. Gold and palladium escape in the form of vapor, and may be easily collected by making the flame which issues from the furnace pass through an earthenware tube, in which will be deposited all the volatile matters except the osmic acid, which may be condensed if the vapor is made to pass over a vessel full of ammonia. A part of the osmium is also deposited in the tube in a metallic state.

The only caution to be observed in the process is never to have the bath of metal of more than 4 or 5 centimetres thickness without keeping it in constant agitation; because the platinum is too bad a conductor to remain perfectly liquid if it is in greater depth; and, therefore, there will be a chance of the refining not being complete, or of the perfect fusion of the mass not being quite effected.

Coal Oil as a preservative for Sodium and Potassium.

The following statement is sent to us by an anonymous correspondent.

To the Editor of the Journal of the Franklin Institute.

Coal oil is a better article for preserving sodium and potassium than naphtha. In coal oil, sodium keeps its lustre for months or years; while, in the purest naphtha, it loses it in a few days.

Yours, &c., A. C.

Philadelphia, May 28, 1860.

A Course of Six Lectures (adapted to a Juvenile Auditory), consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces—including an Account of their Relations to each other.** By M. Faraday, D.C.L., F.R.S., Fullerian Professor of Chemistry, R. I., Foreign Associate of the Academy of Sciences, Paris, &c.

Lecture I. (Dec. 31, 1859.)—*The Force of Gravitation.*

It grieves me much to think that I may have been a cause of disturbance in your Christmas arrangements, for nothing is more satisfactory to my mind than to perform that which I undertake; but such things are not always left in our own power, and we must submit to circumstances as they are appointed; I will to-day do the best I can; I will ask you to bear with me if I am unable to give more than a few words; and as a substitute I will endeavor to make the *illustrations* of the sense I try to express, as full as possible; and if we find by the end of this lecture that we may be justified in continuing them, thinking that next week our power shall be greater—why then, with submission to you, we will take such course as you may think fit; either go on or discontinue them; and although I now feel much weakened by the pressure of illness (a mere cold) upon me, both in faculty of expression and clearness of thought, I shall here claim, as I always have done on these occasions, the right of addressing myself to the younger members of the audience,—and for this purpose, therefore, unfitted as it may seem for an elderly infirm man to do so, I will return to second childhood and become, as it were, young again amongst the young.

Let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise; and I do think, that, to a young person of ten, fifteen, or twenty years of age, perhaps the first sight of a cataract or a mountain would occasion more surprise in him than he had ever felt concerning the means of his own existence; how he came here; how he lives; by what means he stands upright; and through what means he moves about from place to place. Hence, we come into this world, we live, and depart from it, without our thoughts being called specifically to consider how all this takes place; and were it not for the exertions of some few inquiring minds, who have looked *into* these things and ascertained the very beautiful laws and conditions by which we *do* live and stand upon the earth, we should hardly be aware that there was any thing wonderful in it. These inquiries, which have occupied philosophers from the earliest days, when they first began to find out the laws by which we grow, and exist, and enjoy ourselves, up to the present time, have shown us that all this was effected in consequence of the existence of certain *forces* or *abilities* to do things, or *powers*, that are so common that nothing can be

* From the Lond. Chemical News, No. 5.

commoner; for nothing is commoner than the wonderful powers by which we are enabled to stand upright—they are essential to our existence every moment.

Now, it is my purpose to-day to make you acquainted with some of these powers; not the vital ones, but some of the more elementary, and, what we call, *physical* powers; and in the outset, what can I do to bring to your minds a notion of neither more nor less than that which I mean by the word *power* or *force?* Suppose I were to take this sheet of paper, and were to place it upright on one edge resting against a support before me, (as the roughest possible illustration I can give of something to be disturbed), and suppose I pull this piece of string which is attached to it. I pull the paper over. I have, therefore, brought into use a *power* of doing so—the *power* of my hand carried on through this string in a way which is very remarkable when we come to analyze it; and it is by means of these powers conjoined together (for there are several powers here employed) that I pull the paper over. Again, if I give it a push upon the other side, I bring into play a *power*, but a very different exertion of power from the former; or, if I take now this bit of shellac [a stick of shellac about 12 inches long and 1¼ in diameter] and rub it with flannel, and hold it an inch or so in front of the upper part of this upright sheet, the paper is immediately moved towards the shellac, and by now drawing the latter away, the paper falls over without having been touched by anything. You see—in the first illustration I produced an effect than which nothing could be commoner—I pull it over now, not by means of that string or the pull of my hand, but by some action in this shellac. The shellac, therefore, has a *power* with which it acts upon the sheet of paper; and as an illustration of the exercise of another kind of power, I might use gunpowder with which to throw it over.

Now, I want you to endeavor to comprehend that when I am speaking of a *power* or *force*, I am speaking of that which I used just now to pull over this piece of paper. I will not embarrass you at present with the *name* of that power, but it is clear there was a *something* in the shellac which acted by attraction, and pulled the paper over; this, then, is one of those things which we call *power* or *force;* and you will now be able to recognise it as such in whatever form I show it to you. We are not to suppose that there are so very many different powers; on the contrary, it is wonderful to think how few are the powers by which all the phenomena of nature are governed. There is an illustration of another kind of power in that lamp; *there* is a power of heat—a power of doing something, but not the same power as that which pulled the paper over; and so, by degrees, we find that there are certain other powers (not many) in the various bodies around us; and thus, beginning with the simplest experiments of pushing and pulling, I shall gradually proceed to distinguish these powers one from the other, and compare the way in which they combine together. This world upon which we stand (and we have not much need to travel out of the world for illustrations of our subject; but the mind of man is not confined like the matter of his body, and thus he may and does travel outwards, for wherever his sight can pierce, there his observations can penetrate,)

is pretty nearly a round globe, having its surface disposed in a manner of which this terrestrial globe by my side is a rough model; so much is land and so much is water, and by looking at it here we see in a sort of map or picture how the world is formed upon its surface. Then, when we come to examine further, I refer you to this sectional diagram of the geological strata of the earth, in which there is a more elaborate view of what is under the surface of our globe. For, when we come to dig into or examine it (as man does for his own instruction and advantage, in a variety of ways), we see that it is made up of different kinds of matter, subject to a very few powers; and all disposed in this strange and wonderful way, which gives to man a history—and such a history—as to what there is in those veins, in those rocks, the ores, the water springs, the atmosphere around, and all varieties of material substances, held together by means of *forces* in one great mass, 8000 miles in diameter, that the mind is overwhelmed in contemplation of the wonderful history related by these strata (some of which are fine and thin like sheets of paper),—all formed in succession by the forces of which I have spoken.

Now, I shall try to help your attention to what I may say, by directing, to-day, our thoughts to one kind of power. You see what I mean by the term *matter*—any of these things that I can lay hold of with the hand, or in a bag (for I may take hold of the air by enclosing it in a bag)—they are all portions of matter with which we have to deal at present, generally or particularly, as I may require to illustrate my subject. Here is the sort of matter which we call *water*—it is *there* ice [pointing to a block of ice upon the table]—*there* water [pointing to the water boiling in a flask]—*here* vapor—you see it issuing out from the top [of the flask]. Do not suppose that that ice and that water are two entirely different things, or that the steam rising in bubbles and ascending in vapor *there* is absolutely different from the fluid water—it may be different in some things, having reference to the *amounts* of power which it contains; but it is the same, nevertheless, as the great ocean of water around our globe, and I employ it here for the sake of illustration, because if we look into it we shall find that it supplies us with examples of all the powers to which I shall here refer. For instance, here is water—it is heavy; but let us examine it with regard to the *amount* of its heaviness or its gravity. You see here I have a little glass vessel and scales [nearly equipoised scales, one of which contained a half-pint glass vessel], and the glass vessel is at present the lighter of the two; but if I now take some water and pour it in, you see that that side of the scales immediately goes down; that shows you (using common language, which I will not suppose for the present you have hitherto applied very strictly), that it is *heavy*, and if I put this additional weight into the opposite scale, I should not wonder if this vessel would hold water enough to weigh *it* down. [The Lecturer poured more water into the jar, which again went down.] Why do I hold the bottle *above* the vessel to pour the water into it? You will say, because experience has taught me that it is necessary. I do it for a better reason —because it is a law of nature that the water should fall towards the

earth, and, therefore, the very means which I use to cause the water to enter the vessel are those which will carry the whole body of water down. That power is what we call *gravity*, and you see *there* [pointing to the scales] a good deal of water gravitating towards the earth. Now *here* [exhibiting a small piece of platinum] is another thing which gravitates towards the earth as much as the whole of that water. See what a little there is of it—*that* little thing is heavier than so much water [placing the metal in opposite scales to the water]. What a wonderful thing it is to see that it requires so much water as *that* [a half pint vessel full] to fall towards the earth, compared with the little mass of substance I have *here;* and again, if I take this metal [a bar of aluminium about eight times the bulk of the platinum], we find the water will balance that as well as it did the platinum; so that we get, even in the very outset, an example of what we want to understand by the words *forces* or *powers.*

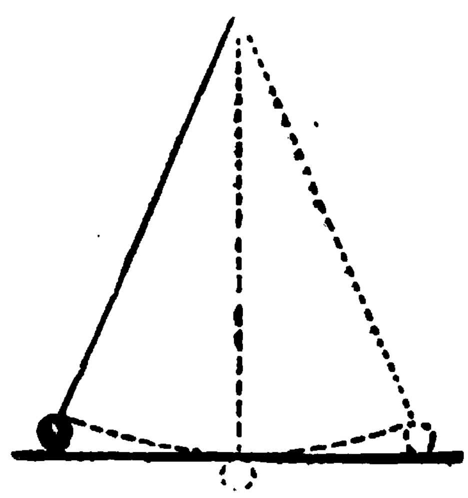
I have spoken of water, and first of all of its property of falling downwards—you know very well how the oceans surround the globe—how they fall round the surface, giving roundness to it, clothing it like a garment; but, besides that, there are other properties of water. *Here*, for instance, is some quick-lime, and if I add some water to it, you will find another power or property in the water. It is now very hot, it is steaming up, and if I had a bit of phosphorus here, or a match, I could perhaps light it. Now that could not happen without a *force* in the water to produce the result; but that force is altogether very different from its power of falling to the earth. Then, again, here is another substance [some anhydrous sulphate of copper] which will illustrate another kind of power. [The Lecturer here poured some water over the white sulphate of copper, which immediately became blue, evolving considerable heat at the same time.] Here is the same water with a substance which heats nearly as much as the lime does, but see how differently. So great indeed is this heat in the case of lime, that it is sufficient sometimes (as you see here) to set wood on fire; and this is the reason of what we have sometimes heard, of barges laden with quick-lime taking fire in the middle of the river, in consequence of this power of heat brought into play by a leakage of the water into the barge. You see how strangely different subjects for our consideration arise, when we come to think over these various matters—the power of heat evolved by acting upon lime with water, and the power which water has of turning this salt of copper from white to blue.

I want you now to understand the nature of the most simple exertion of this power of matter called *weight* or *gravity*. Bodies are heavy—you saw that in the case of water when I placed it in the balance. Here I have what we call a *weight* [an iron half cwt.]—a thing called a weight, because in it the exercise of that power of pressing downwards is especially used for the purposes of weighing; and I have also one of these little inflated india-rubber bladders which are very beautiful although very common (most beautiful things are common), and I am going to put the weight upon it, to give you a sort of illustration of the downward pressure of the iron, and of the power which the air

possesses of resisting that pressure—it may burst, but we must try to avoid that. [During the last few observations the Lecturer had succeeded in placing the half cwt. in a state of quiescence upon the inflated india-rubber ball, which consequently assumed a shape very much resembling a flat cheese with round edges.] There you see a bubble of air bearing half a hundred weight, and you must conceive for yourselves what a wonderful *power* there must be to pull this weight downwards, to sink it thus in the ball of air.

Let me now give you another illustration of this power. You know what a pendulum is. I have one here (Fig. 1.), and if I set it swinging, it will continue to swing to and fro. Now, I wonder whether you can tell me why that body oscillates to and fro —that pendulum bob as it is sometimes called. Observe, if I hold this straight stick horizontally, as high as the position of the ball at the two ends of its journey, you see that the ball is in a higher position at the two extremities than it is when in the middle. Starting from one end of the stick, the ball falls towards the centre, and then rising again to the opposite end it constantly tries to fall to the lowest point, swinging and vibrating most beautifully, and with wonderful properties in other respects—the time of its vibration and so on—but concerning which we will not now trouble ourselves.

Fig. 1.

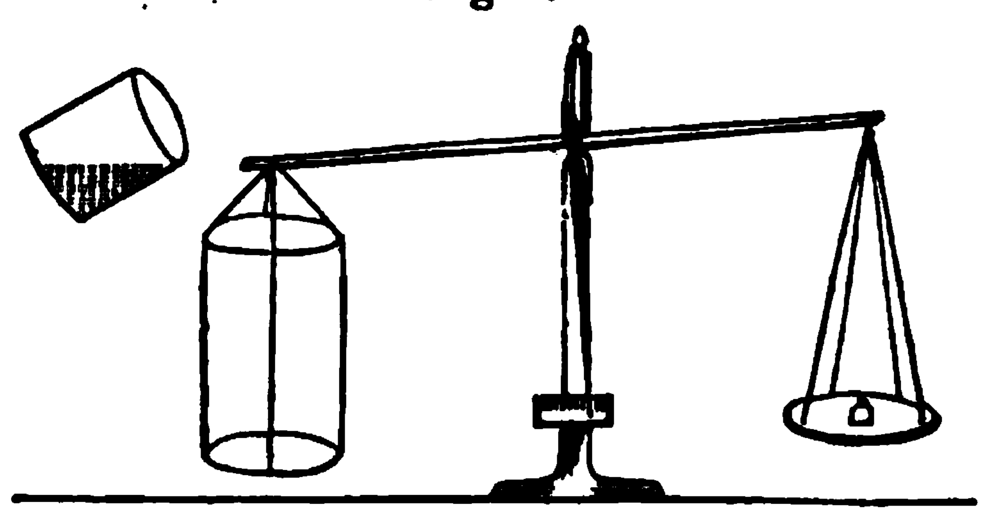


If a gold leaf, or piece of thread, or any other substance, were hung where this ball is, it would swing to and fro in the same manner and in the same time too. Do not be startled at this statement; I repeat, in the same manner and in the same time, and you will see by-and-by how this is. Now, that power which caused the water to descend in the balance—which made the iron weight press upon and flatten the bubble of air—which caused the swinging to and fro of the pendulum, that power is entirely due to the attraction which there is between the falling body and the earth. Let us be slow and careful to comprehend this. It is not that the earth has any *particular* attraction towards bodies which fall to it, but, that *all* these bodies possess an attraction, every one towards the other. It is not that the earth has any special power which these balls themselves have not, for just as much power as the earth has to attract these two balls [dropping two ivory balls], just so much power have they in proportion to their bulks to draw themselves one to the other; and the only reason why they fall so quickly to the earth is owing to its *greater* size. Now, if I were to place these two balls near together I should not be able by the most delicate arrangement of apparatus, to make you, or myself, sensible that these balls did attract one another; and yet we know that such is the case; because if, instead of taking a small ivory ball, we take a mountain, and put a ball like this near it, we find that, owing to the vast size of the mountain as compared with the billiard-ball, the latter is drawn slightly towards it; showing clearly that an attraction *does* exist, just as it did between the shellac which I rubbed and the piece of paper which was overturned by it.

Now, it is not very easy to make these things quite clear at the outset, and I must take care that I do not leave anything unexplained as I proceed, and, therefore, I must make you clearly understand that all bodies are attracted to the earth, or, to use a more learned term, *gravitate*. You will not mind my using this word, for when I say that this penny piece *gravitates*, I mean nothing more nor less than that it falls towards the earth, and if not intercepted, it would go on falling, falling, until it arrived at what we call the *centre of gravity* of the earth, which I will explain to you by-and-by.

I want you, now, to understand that this property of gravitation is never lost, that every substance possesses it, that there is never any change in the quantity of it; and, first of all, I will take as illustration a piece of marble. Now this marble has weight—as you will see if I put it in these scales; it weighs the balance down, and if I take it off, the balance goes back again and resumes its equilibrium. Now I can decompose this marble and change it, in the same manner as I can change ice into water and water into steam. I can convert a part of it into *its own* steam easily, and show you that this steam from the marble has the property of remaining in the same place at common temperatures, which *water*-steam has not. If I add a little liquid to the marble and decompose it, I get that which you see—[the Lecturer here put several lumps of marble into a glass jar, and poured water and then acid over them; the carbonic acid immediately commenced to escape with considerable effervescence]—the appearance of boiling, which is only the separation of one part of the marble from another. Now this [marble] steam, and that [water] steam, and all other steams *gravitate* just like any other substance does; they are all attracted the one towards the other, and all fall towards the earth, and what I want you to see is that *this* steam gravitates. I have here (Fig. 2) a large vessel placed upon a balance, and the moment I pour

Fig. 2.



this steam into it you see that the steam gravitates. Just watch the index and see whether it tilts over or not. [The Lecturer here poured the carbonic acid out of the glass in which it was being generated into the vessel suspended on the balance, when the gravitation was at once apparent.] Look how it is going down. How pretty that is! I poured nothing in but the invisible steam, or vapor, or gas which came from the marble, but you see that part of the marble, although it has taken the shape of air, still gravitates as it did before. Now, will it weigh

down that bit of paper? [Placing a piece of paper in the opposite scale.] Yes, more than that; it nearly weighs down this bit of paper. [Placing another piece of paper in.] So that you now see that *other* forms of matter besides solids and liquids tend to fall to the earth; and, therefore, you will now accept from me the fact that *all* things gravitate, whatever may be their form or condition. Now *here* is another chemical test which is very rapid. [Some of the carbonic acid was poured from one vessel into another, and its presence in the latter shown by introducing into it a lighted taper, which was immediately extinguished.] You see from this also that it gravitates. All these experiments show you that, tried by the balance, tried by pouring it like water from one vessel to another, this steam, or vapor, or gas, is attracted to the earth just like other things.

Now there is another point that I want to draw your attention to. I have here a quantity of shot; each one of these falls separately, and each has its own gravitating power, as you perceive when I let them fall loosely on a sheet of paper. Now if I put them into a bottle I collect them together as one mass, and philosophers have discovered that there is a certain point in the middle of the whole collection of shots that may be considered as the *one point* in which all their gravitating power is centred, and that point they call the *centre of gravity;* it is not at all a bad name, and rather a short one—the centre of gravity. Now suppose I take a sheet of pasteboard, or any other thing easily dealt with, and suppose I run a bradawl through it at one corner A (Fig. 3), and Mr. Anderson holds that up in his hand before us, and I then take a piece of thread and an ivory ball, and hang that upon the awl, then the centre of gravity of both the pasteboard and the ball and string are as near as they can get to the centre of the earth; that is to say, the whole of the attracting power of the earth is, as it

Fig. 3.

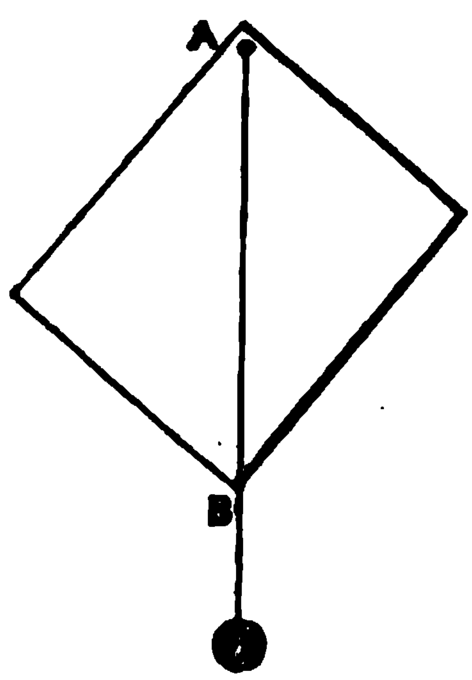
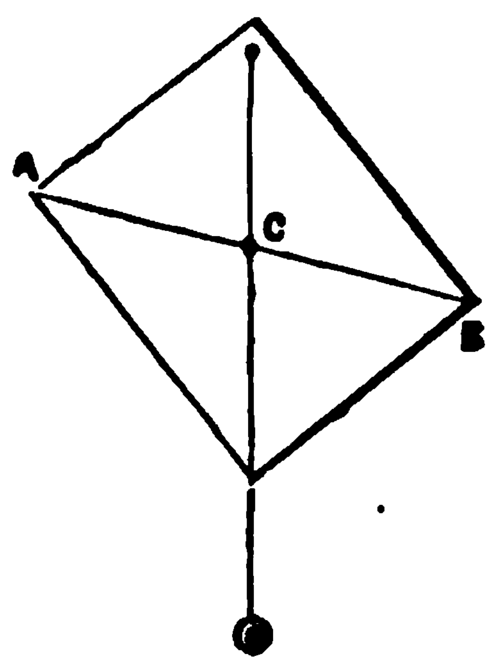


Fig. 4.



were, centred in a single point of the cardboard; and this point is exactly below the point of suspension. All I have to do, therefore, is to draw a line A B, corresponding with the string, and we shall find that the centre of gravity is somewhere in that line. But where? To find that out all we have to do is to take another place for the awl (Fig. 4), hang the plumb-line, and make the same experiment, and

there [at the point C] is the centre of gravity—there where the two lines which I have traced cross each other; and if I take that pasteboard, and make a hole with the bradawl through it at that point, you will see that it will be supported in any position in which it may be placed. Now, knowing that, what do I do when I try to stand upon one leg? Do you not see that I push myself over to the left side, and quietly take up the right leg, and thus bring some central point in my body over this left leg? What is that point which I throw over? You will know at once that it is the *centre of gravity*—that point in me in which the whole gravitating force of my body is centred, and which I thus bring in a line over my foot.

Now I have here a toy, which I happened to see the other day, and I think it will serve to illustrate our subject very well. That toy ought to lie something in this manner (Fig. 5). And it would do so if it were

Fig. 5. Fig. 6.

uniform in substance; but you see it does not, it will get up again. And now philosophy comes to our aid; and I am perfectly sure, without looking inside the figure, that there is some arrangement there by which the centre of gravity is at the lowest point when the image is standing upright; and we may be certain when I am tilting it over (Fig. 6) that I am lifting up the centre of gravity, and raising it from the earth. All this is effected by putting a piece of lead inside the lower part of the image, and making the base of the large curvature, and there you have the whole secret. But what will happen if I try to make the figure stand upon a sharp point? You observe that I must get that point *exactly* under the centre of gravity or it will fall over thus [endeavoring unsuccessfully to balance it]; and this you see is a difficult matter, I cannot make it stand steadily; but if I embarrass this poor old lady with a world of trouble, and hang this wire with bullets at each end about her neck, you see that it is very evident that owing to there being those two balls of lead hanging down on each side, in addition to the lead inside, I have lowered the centre of gravity, and now she will stand upon this point

Fig. 7.

(Fig. 7); and, what is more, she proves the truth of our philosophy by standing sideways.

I remember an experiment which puzzled me very much when a boy. I read it in a conjuring book, and this was how the problem was put to us: "How," as the book said, "how to hang a pail of water, by means of a stick, upon the side of a table." Now I have here a table, a piece of stick, and a pail, (Fig. 8,) and the proposition is, how can that pail be hung to the edge of this table? It is to be done, and can you anticipate what arrangement I shall make to enable me to succeed?

Fig. 8. Fig. 9.

Why this. I take a stick, and put it in the pail between the bottom and the horizontal piece of wood, and thus give it a stiff handle, and there it is; and what is more, the more water I put into the pail, the better it will hang. It is very true that before I quite succeeded I had the misfortune to push the bottoms of several pails out; but here it is hanging firmly (Fig. 9), and you now see how you can hang up the pail in the way which the conjuring books require.

Again, if you are really so inclined (and I do hope all of you are), you will find a great deal of philosophy in this [holding up a cork and a pointed thin stick about a foot long]. Do not refer to your toy-books and say you have seen that before. Answer me rather, if I ask you, have you *understood* it before. It is an experiment which used to seem very wonderful to me when I was a boy; I used to take a piece of cork (and I remember I thought at first that it was very important that it should be cut out in the shape of a man, but by degrees I got rid of that idea), and the problem was to balance it on the point of a stick. Why, you see I only have to stick two sharp pointed sticks on each side, and give it wings, thus, and there you will find this beautiful condition fulfilled.

Fig. 10.

I want now to bring you to another point—all bodies, whether heavy or light, fall to the earth by this force which we call gravity. By observation moreover we see that bodies do not occupy the same time

in falling: I think you will be able to see that this piece of paper and that ivory ball fall with different velocities to the table [dropping them]; and if again I take a feather and an ivory ball, and let them fall, you see they reach the table or earth at different times; that is to say, the ball falls faster than the feather. Now that should not be so, for all bodies do fall equally fast to the earth. There are one or two beautiful points included in that statement. First of all it is manifest that an ounce, or a pound, or a ton, or a thousand tons, all fall equally fast, no one faster than another; here are two balls of lead, a very light one and a very heavy one, and you perceive they both fall to the earth in the same time. Now if I were to put into a little bag a number of these balls sufficient to make up a bulk equal to the large one, they would also fall in the same time; for if an avalanche falls, the rocks and mountains, snow and ice, together falling towards the earth, fall with the same velocity, whatever be their size.

I cannot take a better illustration of this than that of gold leaf, because it brings before us the reason of this apparent difference in the time of the fall. Here is a piece of gold leaf. Now if I take a lump of gold and this gold leaf, and let them fall through the air together, you see that the lump of gold—the sovereign, or coin—will fall much faster than the gold leaf. But why? They are both gold, whether sovereign or gold leaf. Why should they not fall to the earth with the same quickness? *They would do so*, but the air around our globe interferes very much where we have the piece of gold so extended and enlarged as to offer much obstruction on falling through it. I will, however, show you that gold leaf *does* fall as fast when the resistance of the air is excluded—for if I take a piece of gold leaf and hang it in the centre of a bottle, so that the gold, and the bottle and the air within, shall all have an equal chance of falling, then the gold leaf will fall as fast as anything else. And if I suspend the bottle containing the gold leaf to a string, and set it oscillating like a pendulum, I may make it vibrate as hard as I please, and the gold leaf will not be disturbed, but will swing as steadily as a piece of iron would do; and I might even swing it around my head with any degree of force and it would remain undisturbed. Or, I can try another kind of experiment:—if I raise the gold leaf in this way [pulling the bottle up to the ceiling of the theatre by means of a cord and pulley, and then suddenly letting it fall to within a few inches of the lecture table], and allow it then to fall from the ceiling downwards (I will put something beneath to catch it supposing I should be *maladroit*), you will perceive that the gold leaf is not in the least disturbed. The resistance of the air having been avoided, the glass bottle and gold leaf all fall in exactly the same time.

Here is another illustration:—I have hung a piece of gold leaf in the upper part of this long glass vessel, and I have the means, by a little arrangement at the top, of letting the gold leaf loose. Before we let it loose we will remove the air by means of an air pump, and while that is being done let me show you another experiment of the same kind. Take a penny piece, or a half-crown, and a round piece of paper a trifle smaller in diameter than the coin, and try them side

by side to see whether they fall at the same time [dropping them.] You see they do not—the penny piece goes down first.' But, now place this paper flat on the top of the coin, so that it shall not meet with any resistance from the air, and upon *then* dropping them you see they *do* both fall in the same time [exhibiting the effect]. I dare say if I were to put this piece of gold leaf, instead of the paper, on the coin it would do as well. It is very difficult to lay the gold leaf so flat that the air shall not get under it and lift it up in falling, and I am very doubtful as to the success of this, because the gold leaf is puckery; but I will risk the experiment. There they go together! [letting them fall,] and you see at once that they both reach the table at the same moment.

We have now the air pumped out of the vessel, and you will perceive that the gold leaf will fall as quickly in this vacuum as the coin does in the air. I am now going to let it loose, and you must be quick to see how rapidly it falls. There! [letting the gold loose,] there it is, falling as gold should fall.

I am sorry to see our time for parting is drawing so near. As I proceed I mean to put upon the board behind me certain words so as to recall to your minds what we have already examined; and I put the word FORCES above all, and I will then add beneath the names of the special forces in the order in which we consider them; and although I fear that I have not sufficiently pointed out to you the more important circumstances connected with this force of GRAVITATION, especially the law which governs its attraction (for which, I think, I must take up a little time at our next meeting), still I will put that word on the board, and I hope you will now remember that we have in some degree considered the *force of gravitation*—that force which causes all bodies to attract each other when they are at sensible distances apart, and tends to draw them together.

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*Boiler Explosion on the South Devon Railway.**

At the adjourned inquest the following interesting and valuable evidence was given by Capt. Tyler, the government inspector, who said he had examined the engine and the pieces. She began to run in December, 1853, and having run 62,136 miles was retubed in October, 1854. She had had no material repairs since that date. She was a goods engine, with two safety valves, each four inches in diameter, which he considered to be sufficient. The outer shell of her fire-box consisted of three plates, each 6 ft. by 9 ft. 4½ inches by $\frac{7}{16}$ inches thick, the dome being on the top of the centre plate. On Saturday, the 10th, she was slightly repaired. She weighed 35 tons, and had run 12,232¾ miles since she was retubed. When she exploded, three portions of the outer shell of the fire-box flew off, besides some smaller pieces, one of these 4 feet by 13½ inches blew to the left through the side of the shed; a second 4 feet 6 inches by 3 feet six inches fell in the permanent way about 15 feet to the right of the engine, and the third 4 feet 8 inches by 2 feet blew against a wall a distance of 30 yards. A whistle was picked up 330 yards, and a lever 230 yards

* From Herapath's Railway Journal, No. 1066.

from the engine. The portion of the boiler which flew to the left was divided from the other portions just above the line of the seam of rivets, and, therefore, he particularly examined this seam. He found the rivets still in their places. The plate was originally $\frac{7}{16}$ of an inch, but was eaten through in a line regularly from $\frac{3}{16}$ to $\frac{5}{16}$ of an inch, leaving only a very small portion of the metal still holding before the explosion. There was a similar seam on the right of the fire-box which appeared likely to have been eaten away in a similar manner to the portion which had given way on the left. Mr. Wright had this seam broken apart, and he now produced it so that it would afford the jury a better idea of his meaning. This effect had been produced upon the boiler by various causes. In the first place the boiler had evidently been injured during its construction by the application of the caulking tool in caulking the edge of the plate; the surface of all the plates of the boiler that he had been able to see had been more or less injured. He explained that the caulker, which is a kind of cutter, had in the use of it made a kind of cut, and this wound being produced corrosion had taken place. The corroded surface was interfered with by the mechanical working of the boiler, arising from internal pressure, as well as the expansion and contraction due to differences of temperature, and this effect was increased when bad water was used. He found that the Company had great difficulty in getting good water at Newton, up to November, 1858, and the salt water taken from the river was used with this engine twice a-day up to that date. It was partly on this account, no doubt, that the corrosive action to which he had referred had proceeded to so great an extent on so young an engine. There were no means of examining the interior of the fire-box, to detect a flaw of this description, without taking the boiler to pieces or drilling holes in it. There were certain precautions which might be adopted to prevent such accidents for the future. First, by taking additional care to see that the caulking was performed without injury to the boiler; secondly, by the use of good water; thirdly, by the use of additional stays, which would tend to prevent the explosion as well as check the mechanical action referred to; and, fourthly, by testing the boiler periodically by hydraulic pressure, up to, say 50 per cent. beyond the ordinary working pressure of the engine. The valves of this engine were set to a working pressure of 120 lbs. to the square inch, when the explosion took place. Capt. Tyler stated, in addition, but it was not taken as evidence, that a curious fact had occurred since the accident. An engine at Newton was discovered to be in a similarly defective state from the same causes, but, in consequence of its being stayed more effectually, it had resolved itself into a leak.

The Coroner having briefly summed up,

The Jury found a verdict—"That the deceased had been killed by the accidental bursting of the engine boiler." The Jury expressed their satisfaction at the lucid report of Capt. Tyler, and hoped every publicity would be given it with a view to prevent the recurrence of such an accident in the future. They also thanked Capt. Tyler and the officers of the Railway Company for the facilities they had afforded them.

*On the Manufacture of the Carbon Elements for Bunsen Batteries.**

By John Young, Manager of the Gas Works, Dalkeith.

The advantages attending the use of the Bunsen Battery as a powerful source of electric action has led to its very general adoption, especially in those experiments of a more brilliant character. The peculiar construction of this battery consists in substituting for platinum, carbon of that condition found in the interior of gas retorts. The difficulty of procuring carbon of this sort, and especially of giving it a proper form when obtained, led to the series of experiments and their results which form the subject of this communication.

Hitherto the supply of prepared carbons has almost exclusively been furnished to this country from the Continent; and so far as they have come under my observation they were made from the retort carbon above mentioned. The precariousness of a supply from this source, and the fact of its being dependent for its continuance upon an evil which gas engineers are trying all means to overcome, suggested the propriety of finding some compound, and mode of treating it, which would render us equally independent of foreign aid, and that period in the history of gas-lighting when the engineer has attained his object. During the spring of last year these experiments were entered upon; and for several weeks at first occupied my whole attention, and at brief intervals during the summer were resumed. In the first outset we were entirely guided in our procedure by the information of the composition and treatment of the carbons by Professor Bunsen, as given in several works on electrical science; but whether the material used by me or the mode of treatment differed from that of the Professor we do not know, but the results in our hands were most unsatisfactory indeed. The prescribed composition used by the Professor is "coke and coal in fine powder, heated together in an iron mould, thus forming a mass of solid carbon of the required form. To give greater solidity, they were plunged into a syrup of sugar, afterwards dried, and then submitted to an intense heat in covered vessels." These instructions are apparently plain enough, unencumbered by detail, and would indicate, by their brevity, that the *solid mass of carbon* was so sure of being obtained that more minute instructions were totally unnecessary. In our experiments we employed the finest pieces of Newcastle coke in powder and the finest English caking coal, and followed the recipe with great care. We used (1) cold moulds, afterwards heating them carefully; and (2) red-hot moulds, and packed in the composition in a fused state; and yet the four weeks in which we were so occupied were characterized by one series of failures, during which we had wasted large quantities of sugar, besides less valuable materials, without receiving a single hint that we were proceeding in the right direction; and not until a partially new process was entered upon did hopes arise that we would ever attain our object. The carbon elements so obtained were either loose and friable, or altogether in a state of powder, or so full of cracks and fissures, when an excess of

* From the Lond. Chemical News, No. 12.

coal was used, that in either case they were useless. Some of the best we endeavored to finish; but after repeated soakings in the syrup of sugar, we could with difficulty produce them of sufficient density; and, when attainable, only at such expense as precluded competition in price with those already in the market.

Starting anew, and availing ourselves of the varieties of coke within reach, and trusting to our own observations for guidance, we entered upon a new series of experiments with different kinds of coke, mixed in various proportions, and differently treated. Among failures, we also had hints of success, and from noting the changes by which these favorable hints had been furnished, we were able to proceed under more cheering prospects. The results of these experiments were, that the coke from the Marquis of Lothian's parrot coal, as left in the gas retort, was best. What peculiarity in this coke should make it superior we cannot say, unless it be the small amount of ash that it contains; but when used by us, it was always covered by a peculiar glistening, silvery deposit of carbon from its own gas. The amount of ash in the coke we found to be less than 7 per cent.

After many trials, we obtained the best results from the following mixture and mode of treatment—viz: 64 per cent. by weight of coke powder, and 36 per cent. of English caking coal in powder, well mixed, and moistened with a solution of sugar or starch, until the mass, when pressed in the hand, retained its form. When starch was used, it was in the form of mucilage; and when syrup of sugar was used, it was composed of one part of sugar to one and a half of water. The prepared composition was pressed very hard into moulds of the required form, and when taken from the mould the cakes were set aside to dry. The use of sugar or starch in the composition is to cause the adhesion of the particles of coke and coal powder, so that they retain the form of the mould, and when dry become a hard cake that can be handled, and closely packed into the coking-mould. The part of the process referred to is conducted precisely the same as in the manufacture of ordinary bricks; but the similarity of manufacture goes no further, as all air has to be excluded from the carbons, otherwise combustion ensues, and entirely destroys them. To prevent the action of the air, the coking is done inside a gas retort, into which a small quantity of coal had been introduced to expel the air. The box or mould in which the bricks were packed during the coking contained thirteen carbons at one time. The length of the box was equal to the thickness of the whole thirteen, including plates of iron of ⅛-inch thickness, which were placed between them, to prevent the carbons from fusing together.—The breadth of the box was equal to the length of the carbons, and the depth equal to the breadth of the carbons. The mould with cover was so constructed, that the encased carbons should be closely clamped up and compressed between the plates while coking. The great tendency that the caking coal has to tumify while in fusion, by the escape of the gas, made this precaution the more necessary; and unless attended to the carbons would have been loose and porous. The box and its contents were in the retort for about one hour and a half, at a

bright cherry-red heat; and when taken out were covered over with dry dust until cold, to prevent the air from acting on the carbons through the chinks round the cover. When taken from the box the carbons have a close surface, owing to the iron plates compressing the exuding fused coke. At this stage they have no electrical action, and are entirely dependent upon the subsequent parts of the process for the deposit of carbon to bestow this property. From this point in the manufacture, my mode of treatment is new, and depends for the closing of the pores in the coke to the fixed carbon from a soaking of coal tar, and the carbonaceous deposit from gas during its liberation from the coal. My experiments upon sugar, as a source of cementing carbon, showed me that at the best it would be expensive, and exceedingly slow in its action, from the low per centage of fixed carbon that it left. When the syrup used was composed of equal weights of sugar and water, the fixed carbon was only 13 per cent. of the liquid absorbed, or 26 per cent. of the sugar in the solution. At this rate, every ounce weight added to the carbons would cost 1¼*d.* with sugar at its present cheap rate, besides the additional trouble of having the carbons to dry after each soaking. In using coal tar as a substitute, we first heated it to a temperature of 300°, so as to drive off the naphtha hydro-carbons, which left it in a semi-pitched condition; and while still hot the coke bars were soaked in it till saturated, and sank to the bottom. The per centage of fixed carbon left in the coke after the soaking, and heated to redness, was 32·5 per cent. of the tar absorbed, or 2½ times the weight obtained from sugar, and secured at an infinitely less cost. Pure tar carbon is among the best that I have yet tried for Bunsen Batteries, and it was the success in some experiments that I was making with it that induced me to try it as a source of fixed carbon for the purpose now mentioned.

Three separate soakings in the tar, as described, and as many times heated to a high temperature, are necessary fully to close the pores of the coke. Before the last steeping, the carbons are ground upon a flat stone into the required shape. In grinding, a little water is used, but only so much as may form the abraded powder from the carbons into a pasty state; and as the carbons are still absorbent at this stage, they imbibe the water from the paste, and leave the particles of carbon deposited in the pores on the surface, thereby leaving the close surface shown in the finished state. The carbons are again soaked in tar, and charred at a high temperature, when the process is completed by the final smoothing on a flat stone.

The manufacture of the carbons is conducted simultaneously with the process of gas-making; and thereby, with economy of heat, a considerable amount of carbon is deposited from the gas itself, in addition to the fixed carbon from the tar absorbed. For convenience of having them properly placed upon the coal in the retort, a long semicircular trough of iron is prepared (similar to a water run for eaves of houses) to contain from twelve to twenty at one time, and after the charge of coal is introduced, and before closed up, the long trough and its contents are thrust in over the coals, close up to the roof of the retort,

and allowed to remain till the charge of coal is wrought off—a period of nearly three and a half hours. On being withdrawn, the carbons are scattered about, to cool as rapidly as possible, and prevent their burning away by the action of the air; and when cold they receive the slight rub to smooth them, which finishes the process.

I do not wish it to be understood that I consider these carbon elements have reached their perfect state. This notice only shows the process in a comparatively infant stage; and I hope to be able to prosecute the experiments to greater maturity, so as to be able to place a still better article in the hands of the student of electricity.—*Transactions of the Royal Scottish Society of Arts.*

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*Experiments on the Total Heat of Steam.** By J. P. Joule, LL.D., F.R.S.—[Read before the Philosophical Society of Manchester.]

The author showed that what is called the total heat of steam, or the quantity liberated when steam is condensed into water of 0° centigrade, consists of—1st, the true heat of evaporation; 2d, the heat due to the work done on the steam during the condensation; and 3d, the heat liberated by cooling the water from the temperature of condensation to the freezing point. The determination of the total heat of steam had been made the object of a very careful and elaborate research by Regnault; but it appeared to the author that independent experiments, conducted in a different and more direct manner, would not be without interest. The following is a summary of the results obtained by him, compared with those of Regnault:

Total pressure of Steam in Inches.	Total Heat in Degrees Centigrade. Author.	Regnault.
37·25	638·43	638·77
57·52	644·77	642·87
111·58	655·45	649·06

On the Conductibility of certain Alloys for Heat and Electricity.†
By G. Wiedemann.

In an experimental investigation, Wiedemann and Franz‡ found that the thermal and electrical conductibility of metals was nearly identical. Their researches also showed that in brass (which contains 1 part of zinc to 2 of copper) the thermal conductibility differs but very little from that of the worse conducting metal, zinc, although the latter is present in smallest quantity. In other alloys, as those of tin and lead, an analogous relation prevails in reference to the electric conductibility. Messrs. Calvert and Johnson have lately investigated the thermal conductibility of several alloys, and have arrived at results which differ materially from those of Wiedemann and Franz, and which

* From Newton's London Journal, April, 1860.
† From the Lond., Edin., and Dub. Philosophical Mag., March, 1860.
‡ Phil. Mag. [4] vol. vii. p. 33; vol. x. p. 393.

render doubtful the analogy which had been established between the thermal and electrical conductibility. Wiedemann has accordingly determined the conductibility for heat and electricity of several alloys. He used the same method as in the previous researches, and the following Table contains the results at which he has arrived. The standard adopted is silver, the conductibility of which, both for heat and electricity, is taken at 100. Copper zinc $\frac{8}{1}$ denotes an alloy containing 8 parts of copper to one of zinc.

	Conductibility for Heat.	Conductibility for Electricity.
Copper,	73·6	79·3
Copper-Zinc $\frac{8}{1}$,	27·3	25·5
Copper-Zinc $\frac{6\cdot5}{1}$,	29·9	30·9
Copper-Zinc $\frac{4\cdot7}{1}$,	31·1	29·2
Brass $\frac{2\cdot1}{1}$,	25·8	25·4
Zinc,	28·1	27·3
Tin,	15·2	17·0
Tin-Bismuth $\frac{1}{1}$,	10·1	9·0
Tin-Bismuth $\frac{1}{1}$,	5·6	4·4
Tin-Bismuth $\frac{1}{3}$,	2·3	2·0
Rose's Metal,	4·0	3·2

From these results Wiedemann concludes—

1. That the agreement, which had been previously found to exist, between the thermal and electrical conductibility of metals obtains also for alloys.

2. That the conductibilities of alloys of zinc and copper, for heat as well as for electricity, differ but little, even with a considerable excess of copper, from the conductibility of the worse conducting metal, zinc. The alloys of zinc and bismuth, on the contrary, have nearly the mean conductibility calculated from their atomic composition.—Poggendorff's *Annalen*, Nov., 1859.

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*On a Method of Testing the Strength of Steam Boilers.** By Dr. Joule.

The author adverted to the means hitherto adopted for testing boilers. 1st. That by steam pressure, which gives no certain indication whether strain has not taken place under its influence, so that a boiler so tested may subsequently explode when worked at the same or even a somewhat less degree of pressure. He trusted that this highly reprehensible practice had been wholly abandoned. 2d, That by hydraulic pressure obtained by a force pump, which does not afford an absolutely reliable proof that the boiler has passed the ordeal without injury, and moreover requires a special apparatus. The plan which had been adopted by the author for two years past, with perfect success, was

* From Newton's London Journal, April, 1860.

free from the objections which applied to the above, and is as follows: The boiler is entirely filled with water; then a brisk fire is made in or under it. When the water has thereby been warmed a little, say to 70° or 90° Fahrenheit, the safety valve is loaded to the pressure up to which the boiler is to be tested. Bourdon's or other pressure indicator is then constantly observed; and if the pressure occasioned by the expansion of the water increases continuously up to the testing pressure, without sudden stoppage or diminution, it may be safely inferred that the boiler has stood it without strain or incipient rupture.

In the trials made by the author, the pressure rose from zero to 62 lbs. on the square inch in five minutes. The facility of proving a boiler by this method was so great, that he trusted that owners would be induced to make those periodical tests, without which, fatal experience had shown that no boiler should be trusted.

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*On Tungsten Steel.** By F. X. Wurm.

Franz Mayr has produced, at his cast steel works at Kapfenberg, in Styria, cast steel of such dimensions, forms, and excellent quality, as could previously only be obtained from Krupp, of Essen. Oblique cog-wheels for coining machines and locomotives, axles for railway carriages, boiler plates, anglo knees, and round, flat, and quadrangular rods, of various sections, have now been produced by Mayr for more than a year.

What particularly deserves to be mentioned with regard to these articles, is Mayr's unrivalled tungsten-steel distinguished by the fineness of its crystalline texture and its remarkable hardness, so much so, indeed, that the experiments made with it several months ago have shown that tools made from it for cutting toothed wheels, borers, chisels, punches, turning tools, planing blades, &c., retain their power of cutting four times as long as those made of Hundsman-steel, previously regarded as the best. This steel may therefore be recommended as the best for these purposes.

Tungsten has nearly the same specific gravity as gold, and this density is recognisable in the cast steel alloyed with it, by the alteration in the grain of the fractured surface, and by the heightened ring of the steel.

In hardness, metallic tungsten nearly approaches the hardest of natural bodies, and it communicates this property to cast steel, without injuring its tenacity and malleability when the addition is of 2—5 per cent.

The absolute solidity of tungsten-steel exceeds that of all other known steels, for fifteen consecutive experiments with a machine in the Polytechnic Institute of Vienna showed the highest power of resistance to be 1393 hundredweights, and the lowest 1015 hundredweights, giving an average of 1158$\frac{1}{1}\frac{1}{8}$ hundredweights to the square inch; so that this steel exceeds all other kinds hitherto tried.

The ore of tungsten from which the metal is obtained, usually occurs

* From the London Chemical Gazette, No. 403.

in company with tin-stone; it has probably hitherto never obtained any technical application, as it has only been regarded as a mineralogical curiosity.

More recent investigations have shown, however, that the arts may derive considerable benefit from it. One of the richest sources of this ore is possessed by the Austrian empire in the tin mines of Zinnwald in Bohemia, where the tungsten ore has been thrown upon the heaps as worthless for nearly five hundred years.

Mayr has the great merit of having been the first to bring this new and hitherto unemployed metal into use in the manufacture of cast steel on the large scale, having introduced tungstic cast steel into commerce of the most various degrees of hardness, and of any dimensions.

The price of this steel, notwithstanding its remarkable goodness, is lower than that of the English cast steel, over which the uniformity of its crystalline texture gives it a peculiar advantage.

The above properties of density, hardness, and strength, are also communicated by tungsten to cast iron, and this alloy may probably be useful for crushing-rollers, and may perhaps in time attract the attention of the artillery.—Dingler's *Polyt. Journal*, clii, p. 178.

For the Journal of the Franklin Institute.

Particulars of the Steamer Flushing.

Hull built by Samuel Sneden & Co. Machinery by Morgan Iron Works, New York. Designed by T. F. Rowland, Engineer. Owners, New York and College Point and Flushing Steamboat Company. Intended service, New York to Flushing.

Hull.—Length on deck, 161 ft. Do. at load line, 155 ft. Breadth of beam (molded), 27 ft. Depth of hold to spar deck, 8 ft. Frame, L; depth, 3 ins.; width of web, 5-16 in.; width of flanches, 3 ins. Plates, thickness, 5-16 to No. 3. Cross Floors, 12 ins. deep × ½-in., connecting every alternate frame. Keel, depth, 3 ins. Rivets, ⅝-in. diameter; apart, 2½ ins. Bulkheads, 3. Draft when launched, 2 ft. 2 ins. Do. when loaded, 4 ft. Tonnage, 323. Area of immersed section at load draft of 4 ft., 85 sq. ft.

Engines.—Vertical beam. Diameter of cylinder, 36 ins. Length of stroke, 10 ft. Maximum pressure of steam, 50 lbs. Cut-off, 5 ft. Maximum revolutions at above pressure, 27.

Boiler.—One—Return tubular. Length of boiler, 24 ft. Breadth do., furnace, 10 ft., shell, 8 ft. 6 ins. Number of furnaces, two. Breadth do., 4 ft. 6 ins. Length of grate bars, 7 ft. Number of tubes, above, 140. Do. flues, below, 10. Internal diameter of tubes, above, 2¼ ins. Do. flues, below, 6 of 12 ins., 2 of 9 ins., and 2 of 13 ins. Length of tubes, above, 10 ft. Heating surface, 2200 sq. ft. Diameter of smoke-pipes, 3 ft. 6 ins. Height do., 50 ft.

Paddle Wheels.—Diameter over boards, 26 ft. Length of blades, 6 ft. 6 ins. Number of do., 22.

Remarks.—Two box keelsons and four plate keelsons running fore and aft. Iron in hull, 136,000 lbs.

Trial in May, 1859. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Stern-wheel Steamer Vencedor.

Hull built by Samuel Sneden & Co. Machinery by H. Ester & Co., New York. Designed by T. F. Rowland, engineer. Owners, Magdalena Steam Navigation Co. Intended service, Magdalena River.

HULL.—Length on deck, 155 ft. Do. at load line, 150 ft. Breadth of beam (molded), 24 ft. Depth of hold to spar deck, 5 ft. Frame—molded, 6 ins.—sided, 4 ins.—apart from centres, 24 ins. Bulkheads, two. Bottom plank, 2 ft. 5 ins. thick, of yellow pine. Sides, 2 ins. thick, do. do. Decks, white pine, 2 ins. thick. Promenade deck, do., 1 in. thick. Hurricane do., do., ¾-in. do. Draft, forward and aft, loaded, 3 ft. 6 ins. Area of immersed section at load draft of 3 ft. 5 ins., 82 sq. ft.

ENGINES.—Inclined direct. Diameter of cylinder, 16 ins. Length of stroke, 6 ft. Maximum pressure of steam, 120 lbs. Cut-off, variable. Maximum revolutions at above pressure, 35.

BOILER.—One—Locomotive. Length of boiler, 18 ft. 8 ins. Breadth do., 8 ft. 1 in. Height do. exclusive of steam chimney, 7 ft. 6 ins. Number of furnaces, 2. Breadth do., 3 ft. 6 ins. Length of grate bars, 6 ft. Number of tubes, 138. Internal diameter of do., 3 ins. Length of do., 12 ft. Heating surface, 1500 sq. ft. Diameter of smoke-pipes, 3 ft.

PADDLE WHEELS.—Diameter over boards, 16 ft. Length of blades, 17 ft. Depth of do., 15 ins. Number of do., 15.

C. H. H.

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*On Light-house Illumination.—The Electric Light.** By Prof. FARADAY, D. C. L., F. R. S.

[Royal Institution of Great Britain.]

The use of light to guide the mariner as he approaches land, or passes through intricate channels, has, with the advance of society and its ever increasing interests, caused such a necessity for means more and more perfect, as to tax to the utmost the powers both of the philosopher and the practical man, in the development of the principles concerned and their efficient application. Formerly the means were simple enough; and if the light of a lantern or torch was not sufficient to point out a position, a fire had to be made in their place. As the system became developed, it soon appeared that power could be obtained, not merely by increasing the light, but by directing the issuing rays; and this was in many cases a more powerful and useful means than enlarging the combustion; leading to the diminution of the volume of the former with, at the same time, an increase in its intensity. Direction was obtained, either by the use of lenses dependent altogether upon refraction, or of reflectors dependent upon metallic reflection. [And some ancient specimens of both were shown.] In modern times the principle of total reflection has also been employed, which involves the use of glass, and depends both upon refraction and reflection. In all these appliances much light is lost; if metal be used for reflection, a certain proportion is absorbed by the face of the metal; if glass be used for refraction, light is lost at all the surfaces where the ray passes between the air and the glass; and also in some degree by absorption in

* From the Lond. Ed. and Dub. Phil. Mag., April, 1860.

the body of the glass itself. There is, of course, no power of actually increasing the whole amount of light, by any optical arrangement associated with it.

The light which issues forth into space must have a certain amount of divergence. The divergence in the vertical direction must be enough to cover the sea from the horizon, to within a certain moderate distance from the shore, so that all ships within that distance may have a view of their luminous guide. If it have less, it may escape observation where it ought to be seen; if it have more, light is thrown away which ought to be directed within the useful degree of divergence; or, if the horizontal divergence be considered, it may be necessary so to construct the optical apparatus, that the light within an angle of 60° or 45° shall be compressed into a beam diverging only 15°, that it may give in the distance a bright flash having a certain duration instead of a continuous light,—or into one diverging only 5° or 6°, which, though of far shorter duration, has greatly increased intensity and penetrating power in hazy weather. The amount of divergence depends in a large degree upon the bulk of the source of light, and cannot be made less than a certain amount, with a flame of a given size. If the flame of an Argand lamp, $\frac{7}{8}$ of an inch wide and $1\frac{1}{2}$ inch high, be placed in the focus of an ordinary Trinity House parabolic reflector, it will supply a beam having about 15° divergence; if we wish to increase the effect of brightness, we cannot properly do it by enlarging the lamp flame; for though lamps are made for the dioptric arrangement of Fresnel, which have as many as four wicks, flames $3\frac{1}{2}$ inches wide, and burn like intense furnaces, yet if one be put into the lamp place of the reflector referred to, its effect would chiefly be to give a beam of wider divergence; and if to correct this, the reflector were made with a greater focal distance, then it must be altogether of a much larger size. The same general result occurs with the dioptric apparatus; and here, where the four-wicked lamps are used, they are placed at times nearly 40 inches distant from the lens, occasioning the necessity of a very large, though very fine, glass apparatus.

On the other hand, if the light could be compressed, the necessity for such large apparatus would cease, and it might be reduced from the size of a room to the size of a hat; and here it is that we seek in the electric spark, and such like concentrated sources of light, for aid in illumination. It is very true, that by adding lamp to lamp, each with its reflector, upon one face or direction, power can be gained; and in some of the revolving lights, ten lamps and reflectors unite to give the required flash. But then not more than three of these faces can be placed in the whole circle; and if a fixed light be required in all directions round the light-house, nothing better has been yet established than the four-wicked Fresnel lamp in the centre of its dioptric and catadioptric apparatus. Now the electric light can be raised up easily to an equality with the oil lamp, and if then substituted for the latter, will give all the effect of the latter; or by expenditure of money it can be raised to a five or tenfold power, or more, and will then give five or tenfold effect. This can be done, not merely without increase of the volume

of the light, but whilst the light shall have a volume scarcely the 2000th part of that of the oil flame. Hence the extraordinary assistance we may expect to obtain by diminishing the size, and perfecting the optical part of the apparatus.

Many compressed intense lights have been submitted to the Trinity House; and that corporation has shown its great desire to advance all such objects and improve the lighting of the coast, by spending, upon various occasions, much money and much time for this end. It is manifest that the use of a light-house must be never failing, its service ever sure; and that the latter cannot be interfered with by the introduction of any plan, or proposition, or apparatus, which has not been developed to the fullest possible extent, as to the amount of light produced,—the expense of such a light,—the wear and tear of the apparatus employed,—the steadiness of the light for 16 hours,—its liability to extinction,—the amount of necessary night care,—the number of attendants,—the nature of probable accidents,—its fitness for secluded places, and other contingent circumstances, which can as well be ascertained out of a light-house as in it. The electric spark which has been placed in the South Foreland, High Light, by Prof. Holmes, to do duty for the six winter months, had to go through all this preparatory education before it could be allowed this practical trial. It is not obtained from frictional electricity, or from voltaic electricity, but from magnetic action. The first spark (and even magnetic electricity as a whole) was obtained twenty-eight years ago. (Faraday, Philosophical Transactions, 1832, p. 32.) If an iron core be surrounded by wire, and then moved in the right direction near the poles of a magnet, a current of electricity passes, or tends to pass, through it. Many powerful magnets are therefore arranged on a wheel, that they may be associated very near to another wheel, on which are fixed many helices with their cores like that described. Again, a third wheel consists of magnets arranged like the first; next to this is another wheel of the helices, and next to this again a fifth wheel carrying magnets. All the magnet-wheels are fixed to one axle, and all the helix wheels are held immovable in their place. The wires of the helices are conjoined and connected with a commutator, which, as the magnet-wheels are moved round, gathers the various electric currents produced in the helices, and sends them up through two insulated wires in one common stream of electricity into the light-house lantern. So it will be seen that nothing more is required to produce the electricity than to revolve the magnet-wheels. There are two magneto-electric machines at the South Foreland, each being put in motion by a two horse power steam engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines and carbon points for the lamp in the lantern.

The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway; and upon these the lamp stands. When the carbons of a lamp are nearly gone, the lamp is lifted off and another

instantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine house; and when it has become extinguished in the lantern, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across into France, with a power far surpassing that of any other fixed light within sight, or anywhere existent. The experiment has been a good one. There is still the matter of expense and some other circumstances to be considered; but it is the hope and desire of the Trinity House, and all interested in the subject, that it should ultimately justify its full adoption.

For the Journal of the Franklin Institute.

Particulars of the Steamer Daniel Drew.

Hull built by Thomas Colyer. Machinery by Neptune Iron Works, New York. Owners, Daniel Drew and others.

Hull.—Length on deck, 251 ft. 8 ins. Do. at load line, 244 ft. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold to spar deck, 9 ft. 3 ins. Frames—molded, 15¾ ins.—sided, 4 ins.—apart from centres, 30 ins. Keel, depth, 3 ins. Draft, forward and aft, 4 ft. 6 ins.

Engine.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke, 10 ft. Maximum pressure of steam, 35 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 26.

Boilers.—Two—Return flued. Length of boilers, 29 ft. Breadth do., at furnace, 9 ft., at shell, 8 ft. Height do., exclusive of steam chimney, 9 ft. 4 ins. Number of furnaces, two. Length of grate bars, 7 ft. Number of flues, above, 14; below, 10. Internal diameter of do., above, 9½ ins. Do. do., below, 2 of 13½ ins., 1 each of 13, 11, and 7½ ins. Length of do., above, 22 ft. Heating surface, 3350 sq. ft. Diameter of smoke-pipes, 4 ft. Height do., 32 ft.

Paddle Wheels.—Diameter over boards, 29 ft. Length of blades, 9 ft. Depth of do., 26 ins. Number of do., 24.

Remarks.—One independent steam, fire, and bilge pump.

This steamer has been built to attain a very high speed, having a very easy and a very superior model. The velocity of the periphery of her water-wheel blades is 27 miles an hour.

Date of trial, May, 1860. C. H. H

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*British Modular Standard of Length.** By J. F. W. Herschel.

It may not be unwelcome to the scientific portion of your readers to have their attention directed to a simple numerical relation between our actual parliamentary standard of length and the dimensions of the earth, which, in effect, puts us in easy possession of a "modular" system, which might be decimalized, and which, abstractedly considered,

* From the Lond. Athenæum, April, 1860.

is far more scientific in its origin, and, numerically, very far more accurate than the boasted metrical system of our French neighbors. It is simply this,—if the British Imperial standard inch were increased by one-thousandth part it would be, with all but mathematical precision, one five-hundred-millionth part of the earth's axis of rotation.

The calculations of the present Astronomer Royal, published in the year 1830, have determined the length of this axis at 41,707,620 feet, that is to say, 500,491,440 inches of our Imperial standard. Those of Bessel, published in 1841, at 500,487,744 such inches. More recently an elaborate *résumé* of the whole subject, by M. Schubert, has conducted him to three separate and independent conclusions, based on arcs measured each in, or near, a meridian appropriate to the country in which they have been performed, viz: the Russian, the British Indian, and the French arcs. The Russian and the Indian combinations give respectively 500,532,120 and 500,550,168, while the French arc gives only 500,368,920. M. Schubert rejects the latter altogether; but the propriety of doing so appears to Mr. Airy questionable on grounds which we consider so far reasonable as to entitle it to at least half the weight of either of the former. On the other hand, M. Schubert, in computing his mean result, assigns to the Russian result double the weight of the Indian,—a decision in which I can by no means acquiesce. Allowing to each of the former the weight 2, and to the latter 1, the final conclusion from this calculation is 500,506,699; and from the mean of Airy, Bessel, and Schubert, 500,495,294, which differs from 500,500,000 by *less than its hundred-and-six-thousandth part.* This then is the fractional error of our "modular" unit in proportion to its own length of 1·001 British standard inch, or that of a "module" of 50·05 such inches, which, in this view of the subject, might be taken for the British unit of linear measure, or one ten-millionth of the earth's axis. The Astronomer Royal, in discussing these computations of M. Schubert (vol. xx, *Notices of the Royal Astron. Soc.* p. 105), insists, very properly, on the individuality of the polar diameter of the earth as compared with its equatorial diameters, which differ materially in different meridians (having regard to an imaginary sea-level, and independently of the heights of mountains or continents). If any axis be chosen for a scientific unit it should assuredly be the polar axis. The nature of things gives this an absolute, indefeasible preference to every other, not excepting even that of the equator in the meridian of Paris itself.

Every geometer will agree that the radius of a circle is a more fundamental or primary parameter, or unit of linear dimensions, than its circumference. To beings of other psychological constitution than man, it may be otherwise; but take the genus *homo* and the species *geometer* as they stand, this is a fact. *A fortiori*, the axis, major or minor, of an ellipse is a more primary and fundamental unit of its dimensions than its periphery, leaving the question as to *which* axis, major or minor, to be decided on its own grounds.

The French métre is assumed to be the ten-millionth part of the quadrant of the earth's elliptic meridian passing through Paris. Its

value is authoritatively stated in the Annuary of the French Board of Longitude at 39·37079 British Imperial standard inches; and, therefore, in reference to the natural unit in which it originates, is erroneous by one part in 8400 of its proper length, that is to say, between 12 and 13 times more in proportion than our proposed module.

The adoption of such a "British Modular System" of measure requires no Act of Parliament. It is so easy to convert "Imperial standard" lengths, of whatever denomination, into "British modular" lengths of the same denomination by subtracting (or modular into imperial by adding) one-thousandth, that it is not worth while to legislate on the subject, so far as measures of length are concerned. The difference between one part in 1000 and one in 999, in the conversion and re-conversion, being only one in 999,000, is of no importance whatever. Nor is it worth while to change our ordinary parlance. 1 foot or 1 yard, in 1000, is a difference telling as nothing in any practical contract for work on a great scale. On a small one it is quite inappreciable. The scientific man only is interested in it; and it suffices him to know (and the knowledge, to him, is important) that he can refer all his measurements to the best unit nature affords, by subtracting a thousandth (that is, by writing his figures twice over, in two lines, one under the other, shifting the lower three figures to the right, and executing a subtraction sum) far better than by referring to the *Annuaires des Bureaux* of metricized countries, and performing a calculation of greater complexity, landing him in twelve or thirteen times the amount of error. Of course, I am not speaking of a system of *decimalization*. To decimalize our measures we must reduce them to "modular inches," or to "modules" of 50 such inches; but we may speak of modular miles, yards, feet, or inches with reference to a modular unit, while retaining the associations of our actual metrical system. A similar remark applies to the Russian metrical system, which is based upon the English—the fundamental unit being the *Sagene* of ·7 British feet.

I ought, in fairness, to mention that my attention was drawn in the first instance to this *rapprochement* by the statement, over and over again repeated in Mr. Taylor's recent work, entitled "The Great Pyramid, Why was it Built? &c." (Longman, 1859) (pp. 35, 36, 67, 87, 280, 298, &c.,) that the diameter of the earth in the latitude of the Pyramid is 41,666,667 English feet, or 500,000,000 of English inches; which it is not: and it is singular that the reduction of Mr. Airy's polar axis from feet to inches, in page 87, which is rightly performed, does not appear to have suggested the least misgiving as to the correctness of the statement, or (which is more to our present purpose) led him to notice the important practical facility of reduction from the parliamentary to the modular standard above insisted on. It is not my object here to criticize the work in question, which, in the midst of much confusion and no small amount of error, contains some valuable and (so far as we are aware) original remarks. Of these I may mention the conclusion its author has drawn from the angle of slope of the casing-stones discovered by Col. Vyse, that the builders of the Pyra-

mid were acquainted with the ratio of the circumference of a circle to its diameter—a piece of knowledge they were desirous to embody in its dimensions. In fact, the slope of the original faces of the Pyramid comes out from Vyse's (or Perring's) measurement of the linear dimensions of these stones, 51° 52′ 15½″, and by Brettel's measure of their angle, 51° 50′ 0″, the mean of which differs *only by a single second* from the angle whose cotangent is the length of an arc of 45° of the circle, so as to make the whole periphery of the base all but mathematically equal to the circumference of a circle described with the height for a radius. So stated, the coincidence is certainly very striking. It by no means follows, however, that the ancient Egyptians were in possession of any *calculus* by which they could have arrived at a theoretical knowledge of the true ratio. It should be observed that the linear measures above mentioned are given only to entire inches, and those, inches of a scale which may or may not have been verified with extreme precision, and therefore can lay no claim to minute accuracy. Computing, moreover, on these measures alone, the ratio of the periphery to the height comes out 6·2784, while that resulting from the direct measure of the angle is 6·2878, the true ratio being 6·2832. The individual results differ by one 640th part of the whole quantity, and as we do not know with what instruments or what precautions the angle was measured, and it is given only to the nearest minute, it seems but reasonable to admit an equal proportional latitude of uncertainty in the original workmanship and in the numerical relation to which it was intended to conform. Now this is a very considerable approximation, much better than that of Archimedes a thousand years later. Still, it would be easy for people in possession of such appliances as they must have had at command, to ascertain the ratio in question to this, or even to a greater degree of precision, by tracing, for instance, on a flat pavement a circle of 100 feet in diameter and actually measuring the circumference. This they certainly might have done to the nearest half-foot, which, on a length of 314 feet, would correspond to such a latitude of error. If aware of the importance of the problem, they might have gone much further.

But, again, it by no means follows, from any thing which the dimensions of the Pyramid indicate, that they did possess a knowledge of the ratio of the circumference of a circle to its diameter, even approximately. By a very remarkable coincidence, which Mr. Taylor has the merit of having pointed out, the same slope, or one practically undistinguishable from it (51° 49′ 46″), belongs to a pyramid characterized by the property of having each of its faces equal to the square described upon its height. This is the characteristic relation which, Herodotus distinctly tells us, it was the intention of its builders that it should embody, and which we now know it did embody, in a manner quite as creditable to their workmanship as the solution of such a problem was to their geometry. This problem, however, has no relation to that of the rectification of the circle. The coincidence is one as purely accidental as any thing relating to abstract number can be; and although in solving the one problem which we know they did intend,

they at the same time, practically speaking, resolved another which stands in no rational connexion with it, or any connexion beyond that of happening to have, very approximately, the same numerical solution, —we are not entitled to conclude that they were aware of this coincidence, and intended to embody *both* results in their building.

Another curious and novel relation, for pointing out which we are indebted to Mr. Taylor, is one ("Great Pyramid," page 37) which may be most intelligibly expressed under the following form of announcement, viz:—that a belt, encircling the globe, of the breadth of the base of the Great Pyramid, would contain one hundred thousand millions of square feet.* If the feet be Imperial Standard, and the belt Equatorial, this is approximate only to one part in 288 of the whole. But if we suppose the belt meridional, and the area expressed in "modular" square feet, the approximation is within one part in 1100. The fact is interesting as offering the only tolerable approach in round numbers to an arithmetical relation between any of the dimensions of this Pyramid and those of the earth.

* Mr. Taylor has (*in words*) *one hundred millions*, which is a misprint.

Collingwood, April 23, 1860.

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*The Production of Photographic Images on Plates of Glass or Porcelain, by the Action of Light, enabling them to be permanently fixed by being Burnt in with Ceramic Colors.** By John Wyard.

The plates of glass, or porcelain, or other substance, on which the pictures are to be produced, may be glazed prior to the application of the sensitive mixture, or otherwise this glaze or flux may be carried over the finished picture before burning. The first preparation of the plates after cleaning consists in the application of the following sensitive mixture:—

I make separate solutions of gum arabic and gelatine.

Gum Arabic, . .	72 grains.
Sat. Sol. Bichromate of Potass, .	½ oz. by measure.

Dissolve without heat.

Gelatine (Bell's) . . .	15 grains.
Water, . .	1 oz. by measure.
Sat. Sol. Bichromate, . .	1 dr. "

Dissolve in a water bath. When cool, add the sol. bichromate.—Shake well and filter.

Take of the solution of—

Gum Arabic, . .	11 parts.
Solution of Gelatine, . .	5 "
Water Distilled, . .	5 "

To every dram of this mixture add 9 or 10 drops of honey syrup, formed by mixing equal parts in volume of honey and water, and filtering.

* From the Journal of the Society of Arts, No. 385.

This mixture must be heated gently in a water bath, well shaken, and filtered through fine muslin.

The substance on which the picture is to be produced, opal glass, porcelain, ordinary kelp, or plate glass, is slightly warmed by a fire, and a sufficient quantity of the above sensitive mixture poured on, in the same manner as a collodion, drained off, and gradually dried before a fire. The film must be very even. A vigorous positive picture, either from a collodion negative, paper, or albumen, or even an engraving, must be placed in contact with the sensitive surface, and the whole exposed to light—sunlight if possible. The exact amount of exposure is a matter of great importance, from six to ten minutes in good sunshine is in most cases sufficient.

When removed from the light a negative image should be visible, the action of the light darkening and hardening the sensitive layer to a much greater degree when using the above mixture than when using plain gelatine. The sunned parts are harder, and the unsunned softer, than is the case with gelatine alone. The advantage I take of this hardening effect of light on the film of the above will be apparent in the next stage of the process.

I produce a positive image in ceramic color on the plate. This is effected by carrying over the surface of the plate the color in a fine state of division, by means of a pad of cotton wool, well charged with the required color. Its successful application requires some experience. The surface of the plate should be beaten gently and equally, not rubbed. The cotton should occasionally be breathed on, and re-charged with color. The color will be found gradually to adhere to the unsunned parts of the film, and its application should be continued until the picture is considered sufficiently powerful. Almost any amount of vigor may be obtained.

The picture is produced by the parts not exposed to light taking the color, and those portions exposed refusing to take it. The original negative image will now be almost lost to appearance by the superior density of the applied color, forming the positive picture, but there remains in the sensitive coating the changed and unchanged bichromate, which it is necessary to remove.

To effect this I apply alcohol to which has been added dilute acid in the proportion of six drops of the dilute acid to the drachm of alcohol.

The dilute acid contains 5 minims of ordinary nitric acid to the drachm of water. A bath of this may be used, or, if the subject is on a flat surface, the liquid can be poured on. While on the plate evaporation of the alcohol takes place; this would be equivalent to adding too much dilute acid to the alcohol, which would damage the film; therefore, in pouring on and off the liquid, care must be taken to keep up the proportion by adding a little pure alcohol occasionally.

When the brown color of the changed bichromate disappears the acid spirit must be poured off, and pure alcohol poured on and off; this must be repeated once or twice with fresh quantities, it being necessary to remove every trace of the acid and water.

The picture must be dried very rapidly, and is now ready for burn-

ing, provided the recipient has been previously covered with a flux or glaze, if not the flux may be applied over the picture in the following manner. Pour on a solution of Canada balsam in spt. turpentine.—Dry the plate by heat until the turpentine is entirely evaporated.

Prepare the flux, which may consist of borax and glass, or borax, glass, and lead, by grinding it on a slab with water, and drying. Apply this (the flux) equally and evenly, by means of a pad of cotton tied up in very soft and flexible leather.

With respect to the colors used, they are ground on a slab with water, and dried.

The red picture is obtained by peroxide of iron, prepared by calcining the sulphate, and washing the mass with successive lots of boiling water; the dark brown by oxide of manganese.

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*Photo-zincography.** By Colonel Sir HENRY JAMES, R.E., Director of the Ordnance Survey.

In the report of the committee of which Sir R. Murchison was chairman, it is stated that the annual saving effected by my having introduced this (the photographic) method of reducing the Ordnance plans from the larger to the smaller scales, amounted in the year 1858 to £1615. Since then we have so much reduced the cost of the photographs, that the saving which will be effected will amount to £35,000 in the cost of the survey. Up to this period we have exclusively used the paper prepared with nitrate of silver for printing the number of copies required; but we have made experiments with the printing paper prepared with the bichromate of potash, gum, and lamp black, or any other pigment, called the chromo-carbon process of printing.

The action of light on a coating of this composition produces the peculiar effect of rendering it insoluble in water, and consequently when a sheet of paper coated with it is placed in the printing frame under the collodion negative, the outline of the plan is rendered insoluble in water, and remains on the paper when all the remainder of the composition is washed away, and thus we have a "positive" plan in ink of any color which may be required.

In comparing the reduced plans obtained by this process with those obtained by the use of paper prepared with the nitrate of silver, we obtain no advantage whatever, but, on the contrary, the prints are less clear and sharp in their outline.

But by a new mode of treatment of these *chromo-carbon* prints which has been introduced by Capt. A. de C. Scott, R.E., who has charge of this branch of the work, and Lance-Corporal Rider, R.E., who is a good photographer, and also possesses a considerable knowledge of chemistry, we can produce very sharp, clear lines. The ink of the print after being soaked in a saturated solution of caustic potash or soda becomes, so to speak, disintegrated, and is then in a state which enables us at once to rub down the print and transfer the outline to the waxed surface of a copper plate for the engraver. This promises

* From the Lond. Mechanics' Magazine, April, 1860.

to be of great importance to us, as after obtaining the photographed reductions of the maps we have hitherto been obliged to make tracings from them in ink, for the purpose of transferring the plan to the copper, the expense and delay of which will now be saved, whilst we run no risk of any error being made by the draughtsman.

We have also tried a method which is still more valuable and by which the reduced print is in a state to be at once transferred to stone or zinc, from which any number of copies can be taken, as in ordinary lithographic or zincographic printing, or for transfer to the waxed surface of the copper plates. To effect this, the paper after being washed over with the solution of the bichromate of potash and gum, and dried, is placed in the printing frame under the collodion negative, and after exposure to the light, the whole surface is coated over with lithographic ink, and a stream of hot water then poured over it; and as the portion which was exposed to the light is insoluble, whilst the composition in all other parts being soluble is easily washed off, we obtain at once the outline of the map in a state ready for being transferred either to stone, zinc, or copper plate, or we can take the photograph on the zinc at once.

This new method of printing from a negative is extremely simple and inexpensive, and promises to be of great use to us. Sheet 96, of Northumberland, has been transferred to the copper plate from impressions taken from this process, and from the perfect manner in which we are able to transfer the impressions to zinc, we can, if required, print any number of faithful copies of the ancient records of the kingdom, such as "Doomsday Book," the "Pipe Rolls," &c., at a comparatively speaking very trifling cost. I have called this new method Photo-zincography, and anticipate that it will become very generally useful, not only to government, but to the public at large, for producing perfectly accurate copies of documents of any kind.

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*Singular Effect of Lightning.**

At the November Meeting of the Philosophical Society of New South Wales, held in the hall of the Australian Library, a very curious circumstance was brought under the notice of the members present, by Professor Smith, respecting the singular effect of lightning upon a gas-pipe. Alluding to the phenomenon, the Professor says:—

"In his laboratory at the University, recently, he had had a connexion made with the iron pipes brought up from the city; the gas-pipe was laid along the front of the building, below the surface of the ground. The pipe was a cast iron one, three inches in diameter, and the connexion with the laboratory was by a small iron pipe, joining a tin pipe, under the floor. There was also a system of lead water-pipes, following nearly the course of the tin gas-pipe, and terminating underneath the door-way, where the gas-pipe entered the laboratory; at this point, or just inside the door-way, the tin gas-pipe touched the lead

* From the Lond. Jour. of Gas Lighting, &c., No. 191.

water-pipe. On Monday afternoon, he left his gas-holder half full of gas—there was nearly twenty cubic feet in it. The stop-cock, between the outside pipe and the laboratory, was closed, and the junction with the gas-holder left open. On Tuesday morning, he tried to light the gas, but found there was none. On going round to ascertain the cause, he found that his gas-holder was empty, though all the stopcocks were shut; and then, on opening the outside stop-cock, he found that there was no pressure on the pressure-gauge, but he soon observed that the room was getting full of gas, from which he inferred that there must be somewhere in the pipe a hole as large as its diameter; otherwise, there would have been some pressure on the gauge. It then occurred to him that this accident might be connected with the fact that, on Monday afternoon, November 14, the University had been struck by lightning; in one of the shears on the tower a deep groove, an inch wide, had been cut out, and there was a terrific crash, suggesting to those in the building the idea that the roof had fallen in. There was a lightning conductor attached to a chimney of the laboratory, and this entered the ground eighteen feet from the gas-pipe, terminating six feet below the surface, in a large copper plate. On sending for the plumber who laid the pipes, he suggested that a rat had gnawn through the pipe on finding it obstructing his way; but, on taking up the flooring, they discovered that the accident must have been due to lightning. On the one side of the pipe, where it had touched the lead water-pipe, was an irregular oval aperture, about an inch long and half an inch wide, and right opposite, on the other side of the pipe, was a smaller rounded aperture, measuring half an inch by three-eighths, the tin being thinned away as if it had been beaten out. A lump of melted tin, weighing 45 grains, lay before the orifice. What had happened was tolerably clear. One of the pipes had been conveying a very powerful charge of electricity, and, coming to the point where it touched the other, the electricity preferred changing its route, and in leaping from the one to the other, it made two great holes. He observed that there was an indent in the lead water-pipe, and a piece of the lead melted. It was a puzzling thing to account for the hole at the back of the pipe. The corner of a brick touched it at that part, and the aperture there had quite a different appearance from that on the other side, the edge on one side (next the brick) being thin and sharp, while on the other it was thickened and melted. The blackening inside the pipe could be accounted for by the gas being decomposed by the electricity. There were many curious points connected with this case. In the first place, where did the lightning come from? He could scarcely imagine that the discharge could have come from the tower, and run along the pipe, which was buried in the ground for nearly two hundred feet. It seemed more probable that the discharge was delivered by the laboratory conductor, and had then passed through the ground to the gas-pipe, though that was eighteen feet away. He thought it might have come along the gas-pipe first, and then taken to the water-pipe as a better conductor. There was still another supposition, however; and, perhaps, the most probable one.

The lightning might have struck the south-east corner of the laboratory, and, being conducted by the lead gutter to the lead cistern under the roof, and thence down the water-pipe to the laboratory, making its exit by the gas-pipe. If this supposition be correct, it shows how limited was the protective power of the lightning conductor attached to a neighboring chimney. The man at the turnpike saw the lightning strike the University; he described it not as a flash of light, but as a ball of fire, which came down in front of the building. It was remarkable that the gas was not ignited by the electricity, and the laboratory set on fire."

A conversation ensued upon the subject, remarks being made upon the action of the lightning as very remarkable, and Professor Smith's explanations were considered fully satisfactory.

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*Decay of Stone.**

SIR:—The cause of the destruction of the stone of the new places at Westminster is undoubtedly the sulphuric acid that is always present in the atmosphere of London, arising from the combustion of coal, which always contains a considerable per centage of sulphur. I noticed this destruction of the stone going on in 1854, when up in London giving evidence before a committee of the House. I then minutely examined the building, and found abundant evidence of decay. My attention was first called to this destructive action of the sulphuric acid in the atmosphere of large towns ten years ago. Having observed a white efflorescence on the bricks and stones of this town [Leeds] where-ever there was damp, I analyzed and found it to be sulphate of magnesia and sulphate of lime. I also found sulphuric acid in the air. Combustion of coal is the only source whence so considerable a quantity of acid could be evolved into the air, as all coal contains about one per cent. of sulphur, whose combustion must keep the air of large towns always acid. This acid state of the air is causing serious damage here, as the only lime used is magnesian lime. The sulphate of magnesia formed is dissolved during rain, absorbed into the bricks or stones, and, when dry weather comes, it crystallizes and splits off the face of the bricks or stones like frost.

No magnesian stone or lime should be permitted in large towns, as the acid will act alike on the stone and mortar. The stone of the new palaces is magnesian limestone, and, unless a protection be found, all the mouldings and other parts liable to damp will rapidly decay.

As to the remedy proposed,—an alkaline silicate, or, as it is called, soluble glass,—will, in my opinion, be worse than the disease, as the acid atmosphere will decompose it as easily as the stone. The proper remedy will be to oil the stone with boiled linseed oil, which will prevent it being moist and attracting the sulphuric acid. The oil will not alter the color, and will effectually protect the stone.

C. L. DRESSER, F.C.S.

*** Oiling, in the case of Caen stone, if not of others, is known to have failed.—ED.

* From the Lond. Builder, No. 863.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM APRIL 1, TO APRIL 30, 1860.

Adding Numbers,—Machine for	D. R. Nelson, .	Jackson,	Ohio,	24
Air Engines,—Compressed	W. C. Turnbull,	Baltimore,	Md.	17
Alarm Lock, .	Joseph Ziegler, .	"	"	10
Amalgamators, .	I. W. Knox, .	San Francisco,	Cal.	24
Artesian Wells,—Boring	John Taney, .	Austin,	Texas,	17
Auger, .	James Blake, .	East Pepperell,	Mass.	17
Axe Handles,—Fastenings for	James E. Emerson, .	San Francisco,	Cal.	10
Bank Notes,—Manufacture of	Augustus C. Carey,	Lynn,	Mass.	10
Barrel Heads,—Manufacturing	L. B. Batcheller, .	Rochester,	N. Y.	3
Bed Bottom,—Spring .	J. Bailey and J. Decamp,	Cincinnati,	Ohio,	3
Bed-cord Tightener,	A. B Stroup, .	Waldron,	Ind.	10
Bed,—Spring .	John H. Crane, .	Charlestown,	Mass.	3
Bee-hives, .	Robert Hawkins, .	Bealsville,	Penna.	24
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Bells,—Hanging .	T. H. Bell, .	Washington,	D. C.	17
Belt Fastening, .	G. W. Blake, .	Pepperell,	Mass.	24
Belting, .	Henry Underwood, .	City of	N. Y.	10
———,—Making Rubber	Thomas J. Mayall,	Roxbury,	Mass.	3
Bench Planes, .	H. C. Hunt, .	Ottumwa,	Iowa,	24
——— Vise, .	L. A. Beardsly, .	S. Edmeston,	N. Y.	24
Boilers for Hot water apparatus,	Edmund B. Cherevoy,	City of	"	10
Bolts,—Heading .	Hiram Abbott, .	Wakeman,	Ohio,	17
Bonnet Frames,—Manuf. of	R. T. Wilde, .	City of	N. Y.	24
Boots and Shoes,—Planes for	E. S. Snell, .	N. Bridgewater,	Mass.	10
————————,—Heels for	J. V. Dinsmore, .	Auburn,	Maine,	3
————————,—Overshoes &	McEwen and Patterson,	Kingston,	Tenn.	17
Boxes,—Finishing Wooden	H. A. Jones, .	St. Louis,	Mo.	24
———,—Metal Caps for .	Deidrich and Slocum,	Philadelphia,	Penna.	3
Bridges,—Truss .	G. O. Bishop, .	Hannibal	Mo.	24
Brooms,—Metal Head for	H. G. Smith, .	Muscatine,	Iowa,	3
Buckles, .	John C. Hall, .	Fayette,	Miss.	3
Bullet Ladle, .	George Rugg, .	Potsdam,	N. Y.	24
Burglars Alarm, .	George W. Bigelow,	New Haven,	Conn.	10
Butt Hinges, .	George H. Fayman,	Washington,	D. C.	10
Candle Machines,—Making	Michael Massey, .	Cleveland,	Ohio,	24
Candles,—Moulding .	William Thomas,	City of	N. Y.	3
Cane Presses, .	Eugene Powell, .	Conneautville,	Penna.	10
Caoutchouc,—Vulcanizing	Asahel K. Eaton,	Kings County,	N. Y.	3
————————	Charles T. Harris, .	N. Brunswick,	N. J.	10
Car Axles, .	L Brown, & J & J Leland,	Worcester,	Mass.	24
—— Couplings, . .	Ruel Rawson, .	Quincy,	Mich.	3
Carpenters Clamp, .	John Cadwell, .	Cincinnati,	Ohio,	24
Carpet Beater and Cleaner,	A. Cutler & E. S. Wright,	City of	N. Y.	10
Carriage Seats,—Sliding	Wm. A. Bird, .	Newark,	N. J.	17
——— Springs, .	Edward Maynard, .	Brooklyn,	N. Y.	3
Cartridge Cases, .	George P. Foster,	Providence,	R. I.	10
Cartridges,—Filling Metallic	H. Smith & D. B. Wesson,	Springfield,	Mass.	17
Carving Marble, &c., .	William H. Pease, .	Goshen,	Ind.	10
Chair Caster, .	Thomas Fry, .	Brooklyn,	N. Y.	10
Cheese Presses, .	Myron E. Taft, .	Potsdam,	"	10
Chucks for cut'g Discs of paper,	Mathaus Kaefer,	City of	"	10
Churn, . .	Daniel Deshon (2d), .	Somerset,	Penna.	3
——— .	Edward Lynch, .	Buffalo,	N. Y.	10
——— . .	S. P. Dunham & A. Hipple,	Kilbourne,	Ohio,	17
——— .	Jehu Mitchell, .	Aleppo towns'p,	Penna.	17
Cigar and Match Cases, .	P. J. Clark, .	West Meriden,	Conn.	3
Clocks,—Winding Spring of Air	Charles B. Hoard,	Watertown,	N. Y.	3
Clock Weights,—Constructing	Richard F. Bond, .	Cambridge,	Mass.	3

Clothes-wringer, .	Elliot Dickerman,	Richmond,	Vt.	10
Coal and Ores,—Purification of	Jesse Burroughs, .	Ridgway,	Penna.	3
——, &c.,—Buckets for remov'g	J. S. Lloyd, .	Salem,	N. J.	24
Combs, .	E. M. Noyes, .	Newark,	"	24
Coopers' Tool, .	J. P. Woods, .	Troy,	N. Y.	17
Corn Harvesters, .	Adam Humberger, .	Somerset,	Ohio,	3
—— Huskers, .	N. T. Spear, .	City of	N. Y.	10
—— Planters, .	G. W. N. Yost, .	Yellow Springs,	Ohio,	3
———— .	Martin A. Howell, Jr.,	Ottawa,	Ill.	10
—— Shellers, .	Nathaniel Drake, .	Newton,	N. J.	3
—— Shock-binders, .	Calvin Stowe, .	Braceville,	Ohio,	24
Cotton Thinning Ploughs,	L. B. Joyner, .	Hilliardston,	N. C.	24
——— Bales,—Metal Hoops on	John McMurtry,	Fayette Co.,	Ky.	10
——— Seed Planters,	S. P. Sweeney, .	Columbia,	Texas,	3
Coupling Attachment for Cords,	J. L. Howard, .	Hartford,	Conn.	17
Cradle,—Child's .	L. K. Selden, .	Haddam,	"	10
———,—Infant's .	S. F. Brooks, .	Weston,	Mass.	24
Crank,—Overcoming Points of	John P. Cooper, .	Finleyville,	Penna.	3
Cultivator Teeth, .	Heman B. Hammon,	Bristolville,	Ohio,	10
———— .	G. C. Aiken, .	Nashua,	N. H.	24
Cultivators, .	W. B. Dorsay, .	Decatur,	Ill.	3
———— .	John G. Christopher,	Byron,	"	10
———— .	J. F. Eylar, .	Scott,	Ohio,	24
———— .	I. R. Smith, .	Elgin,	Ill.	24
————,—Corn & Cotton	G. T. Bennett, .	Mount Olive,	N. C.	24
————,—Hand .	P. S. Clinger, .	Conestogà Cen.	Penna.	3
Curtain Fixture, .	Edward Brown,	Waterbury,	Conn.	3
———— .	Joseph Smith, .	City of	N. Y.	3
————,—Window	Tanner and Gorton,	Paw Paw,	Mich.	3
Cutlery,—Securing Handles of	R. H. Fisher, .	Beverly,	N. J.	10
Door Numbers,—Casting	J. T. Fuller, .	Louisville,	Ky.	10
Eave Troughs,—Making	Loomis Mann, .	Ionia,	Mich.	17
Egg-beater, .	J. M. Jay and J. Danner,	Canton,	Ohio,	17
Elevators for Hay, &c., .	F. F. Fowler, .	Crane towns'p,	"	17
Emery Cloth,—Substitutes for	Thomas J. Mayall,	Roxbury,	Mass.	10
Enameling Mouldings, Machine	Richard Ten Eyck, Jr.,	Brooklyn,	N. Y.	24
Etching Stone,—Composition for	A. Hoen, .	Baltimore,	Md.	24
Evaporators,—Rotary .	A. H. Miller, .	La Porte,	Ind.	24
Excavators,—Dirt-loading for	William Cooper,	Mount Gilead,	Ohio,	3
Eyelet Machines, .	William Steinmetz, .	Philadelphia,	Penna.	17
Faucets,—Measuring,	George K. Babcock,	Utica,	N. Y.	3
Fence,—Making Picket .	J. Moore and A. Kelly,	Pittsburgh,	Penna.	17
Fertilizers,—Sowing	William D. Mason,	Jarrett's Depot,	Va.	3
Fibrous Materials,—Reducing	S. M. Allen, .	Niagara Falls,	N. Y.	17
Figures, &c.,—Copying .	F. C. Meyer, .	Philadelphia,	Penna.	24
Files, .	Pietro Cinquini, .	West Meriden,	Conn.	3
Fire-arms,—Breech-loading	J. Letort & H. S. Matthews,	Wytheville,	Va.	3
————	Calvin Cox, .	Coxville,	N. C.	10
————	G. P. Foster, .	Providence,	R. I.	10
————,—Revolving .	F. D. Newbury, .	Albany,	N. Y.	10
Fire Escape, .	Deckelman and Spiess,	City of	"	24
———— .	Adolphus Lippman, .	"	"	24
—— Ladders,—Truck for	Mickle and Carville,	"	"	10
—— Places, .	James K. Ross, .	Lebanon,	Ohio,	3
———— .	T. F. Card, .	Cincinnati,	"	17
—— Plugs,—Casting .	Wm. M. and J. B. Ellis,	Washington,	D. C.	17
Fire-proof Safes, .	Gregor Menzel, .	Milwaukie,	Wis.	24
Flour Separators, .	Stephen Hughes, .	Hamilton,	Ohio,	17
Fluid Lenses, .	Seligman Kakeles,	City of	N. Y.	24
Fly Brush or Fan, .	Marcus Laveen, .	Moorefield,	Va.	10
Forge Bellows, .	William Thompson,	Detroit,	Mich.	17
Fork and Spoon,—Culinary	Andrew Hills, .	Naugatuck,	Conn.	10
Furnaces, .	Peter Low, .	Cincinnati,	Ohio,	3

Garden Hoes, .	John R. Albertson, .	E. Deertowns'p,	Penna.	3
Gas,—Instruments for Lighting	Damarin and Brower,	New Orleans,	La.	24
—— Lights,—Reflector for	Isaac P. Frink, .	Newark,	N. J.	17
—— Metres,—Dry .	Charles L. Vasquez,	Philadelphia,	Penna.	10
—— Retorts,—Siphons to	Harvey Guild, .	New Orleans,	La.	3
Gases,—for Generating	Samuel Chamberlaine,	Philadelphia,	Penna.	10
Glass Moulds, .	C. H. Warner, .	Brooklyn,	N. Y.	10
Grain by Sulph. acid,—Bleach'g	J. M. Clark, .	Philadelphia,	Penna.	17
—— Drying Machines,	T. H. McCulloch, .	Peoria,	Ill.	17
—— Scales,—Automatic	Albert Gummer,	Indianapolis,	Ind.	3
—— Separators, .	Jacob Schaefer, .	Henderson,	Ky.	10
—— .	J. H. McGehee, .	Athens,	Ala.	17
—— .	George Westinghouse,	Schenectady,	N. Y.	17
—— .	J. A. Vaughn, .	Cuyahoga Falls,	Ohio,	24
——,—Weighing .	John Williams, .	Kalamazoo,	Mich.	10
Gum from machinery,—Remov'g	Samuel Maxwell,	Baltimore,	Md.	24
Hammers,—Atmospheric	Milo Peck, .	New Haven,	Conn.	17
Hand Trucks, .	Jonas Underkofler,	Philadelphia,	Penna.	24
Harness Pads, .	James Ives, .	Mount Carmel,	Conn.	24
Harvesters, .	Jacob L. Paxson,	Norristown,	Penna.	10
—— .	Lewis C. Reese, .	Phillipsburgh,	N. J.	10
—— .	A. and N. Kane,	City of	N. Y.	24
——,—Cutting appa's for	George Fetter, .	Philadelphia,	Penna.	3
——,—Rakes for	W. P. Penn, .	Belleville,	Ill.	24
Harvesting Machines, .	Bennett F. Witt, .	Dublin,	Ind.	10
——	Martin Hallenbeck,	Albany,	N. Y.	17
Hat Rack for Cigars, &c.,	Charles Branwhite, .	Williamsburgh,	"	24
Hats, .	J. R. Ender, .	Trenton,	La.	17
——,—Manufacture of .	Warburton and Lovett,	Philadelphia,	Penna.	10
——,—Ventilators for	James Jenkinson,	Brooklyn,	N. Y.	24
—— .	Julius Pollock, .	Morrisania,	"	3
Head-supporting Apparatus,	Henry C. Howells,	City of	"	10
Heat Radiators, .	D. G. Fletcher, .	Racine,	Wis.	17
Hoisting Hay, &c.,—Machines	J. S. Lloyd, .	Salem,	N. J.	24
Hoisting Wheels,—Operating	John McMurtry, .	Fayette Co.,	Ky.	3
Horses Feet from Interfering	William Somerville,	City of	N. Y.	24
——,—Stopping Runaway	Joseph Koehler, .	"	"	17
Horse-powers, .	Charles S. Graves,	Elyria,	Ohio,	10
—— .	E. B. Requa, .	Jersey City,	N. J.	17
—— .	Otis W. Stanford,	Cincinnati,	Ohio,	24
Horse-shoe Machine,	T. R. Taylor, .	Cleveland,	"	3
Hose Tubing, .	Charles McBurney,	Roxbury,	Mass.	10
Iron,—Manufacture of	W. G. Brown & F. McKee,	Birmingham,	Penna.	3
——,—Welding Wrought	J. C. Cooke, .	Middletown,	Conn.	3
Journal Boxes, .	I. P. Wendell, .	Philadelphia,	Penna.	10
Knife and Fork Cleaner,	Sewall Brackett,	Fall River,	Mass.	10
—— Sharpener and Cleaner,	John M. Farman, .	Hartford,	Conn.	17
Ladder,—Extension .	Mickle and Carville,	City of	N. Y.	10
Ladders,—Extension	F. Kavemann and others,	Cincinnati,	Ohio,	24
Lanterns, .	P. A. Morley, .	Brooklyn,	N. Y.	17
—— .	T. B. DeForest, .	City of	"	10
Lathes, .	John Cook, .	Buffalo,	"	3
Leather-dressing Machine,	R. P. Boyce, .	Erata,	Miss.	17
Letter-copying Presses, .	G. C. Taft, .	Worcester,	Mass.	24
Lightning Rods,—Insulating &c.	Myron Fox, .	Stamford,	Conn.	24
Lock, . .	William E. Worthen,	City of	N. Y.	10
—— and Label sheath,—comp.	Samuel W. Marsh,	Washington,	D. C.	3
Locomotives,—Guide Wheels for	Septimus Norris, .	Philadelphia,	Penna.	24
Locom. Engs.,—Running Gear	John L. Whetstone,	Cincinnati,	Ohio,	10
Looking-glass or Mirror, .	S. F. Brooks, .	Weston,	Mass.	24
Looms, .	James C. Cooke,	Middletown,	Conn.	10

Looms,	Hezekiah Conant,	Willimantic,	Conn.	10
Lubricating Carriage Axles,	James E. Emerson,	San Francisco,	Cal.	17
Mail Bags, &c.,—Labels for	T. P. Trott,	Washington,	D. C.	24
Mangers,	John E. Kelly,	City of	N. Y.	10
Mangle,	George Coombs,	West Falls,	"	17
Match Case,—Portable	D. Ellis and P. Hine,	Waterbury,	Conn.	24
Mills,—Grinding	Edmund Munson,	Utica,	N. Y.	3
Millstone Bush,	Moses French,	Leesville,	Ind.	3
Molasses Gates,—Casting	M. R. Chace,	Fall River,	Mass.	24
Mortising Machine,	Lovett Eames,	Kalamazoo,	Mich.	17
——— Tool,	"	"	"	10
Mosquito Fan,—Automatic	Charles A. Gale,	Boston,	Mass.	10
Mowing Machines,	S. Ray & M. P. Shalters,	Alliance,	Ohio,	10
Needle Case,	T. G. Harold,	Brooklyn,	N. Y.	24
——— Guards,	Joseph C. Howells,	Madison,	Wis.	10
Oil Cans,	William C. Arthur,	Baltimore,	Md.	10
— Cock,	James Hare, Jr.,	Paterson,	N. J.	17
—,—Distillation of Coal	Stombs and Brace,	Newport,	Ky.	10
Oils,———————	Luther Atwood,	City of	N. Y.	10
—,———————Hydro-carb.	"	"	"	10
Ore,—Apparatus for Heating	A. C. Vandyke,	Greenupsburg,	Ky.	24
Ores of Zinc, &c.,—Operations to	Robert George,	Mineral Point,	Wis.	3
Paddle Wheel,	Rollin Germain,	Buffalo,	N. Y.	10
Padlock,	Wilson Bohannan,	Baltimore,	Md.	17
Paper-bag Cutter,	L. D. Barraud,	City of	N. Y.	24
Pen and Pencil Case,	John Cockburn,	"	"	10
—— Stand,	Rooney and Renshaw,	"	"	3
Planes in Moulding,—Adjusting	W. D. Jones,	Dayton,	Ohio,	24
Ploughs,	D. H. and E. E. Smith,	Glenn Spring,	S. C.	3
———	A. Hammond,	Jacksonville,	Ill.	10
———	William D. Ivey,	Milford,	Ga.	10
———	M. C. McCullers,	Herndon,	"	24
———,—Mole	Wall, Roberts & Carter,	Decatur,	Ill.	10
———,—Seeding	C. Atkinson,	Vermont,	"	10
——————	James Peeler,	Tallahassee,	Fla.	24
Printing Presses,	F. O. Degener,	City of	N. Y.	24
Prussian Blue,—Manufacture of	Theodore A. Helwig,	Minersville,	Penna.	3
Pumps,	Cornelius Hood,	Seneca Falls,	N. Y.	17
———	Henry Belfield,	Philadelphia,	Penna.	17
———	Robert Ramsden,	S. Easton,	"	24
———	Levi Matthews,	Antrim,	Ohio,	24
Pumping Water,—Wind Mach.	F. G. Johnson,	Sag Harbor,	N. Y.	3
Pump Valves,	William Jeffers,	Pawtucket,	R. I.	17
Punches,	Adoniram J. Fullom,	Springfield,	Vt.	10
Quartz,—Machines for Crushing	Jefferson Short,	Leavenworth,	K. T.	17
——— Mills,—Grind. Surfaces	Ezra Coleman,	City of	N. Y.	3
Railroad Axle Boxes,	Harvey Rice,	Concord,	N. H.	3
——— Car Axles,	James Montgomery,	Baltimore,	Md.	24
——— Cars,	S. J. Seely,	Buffalo,	N. Y.	24
—————,—Brakes for City	Jenks and Steere,	Providence,	R. I.	17
—————,—Framing of	Thomas M. Mullen,	Philadelphia,	Penna.	3
—————,—Running Gear	Richard Hornbrook,	Cincinnati,	Ohio,	24
—————,—Starting City	Solomon N. Sanford,	Cleveland,	"	3
——— Rails, &c.,—Wear of	C. T. Liernur,	Mobile,	Ala.	17
Railroads,—Tracks for City	S. M. Fox,	City of	N. Y.	24
Rakes,—Horse	Lorenzo Beach,	Montrose,	Penna.	10
Reflector,—Night-light	John Wyberd,	City of	N. Y.	10
Refrigerator,	W. M. Baker,	Walpole,	Ind.	3
Roofing,—Board	Freeman Walcott,	Milford,	Mass.	10
Rotary Motion,—Reciprocat'g to	Joshua Hathaway,	Marietta,	Ga.	3

Saddles,—Riding .	John E. Kelly, .	City of	N. Y.	3
——— .	Mortimer Nelson,	"	"	10
Sashes,—Metallic	W. E. Worthen, .	"	"	24
Sausage-stuffer, .	Christian Kramer,	Alleghany,	Penna.	3
——— .	Salmon R. Plumb, .	Southington,	Conn.	10
——— .	John G. Perry, .	S. Kingston,	R. I.	10
Saw-filer, .	J. S. Tripp, .	Danby,	N. Y.	17
Saw-mills, .	C. P. Morton, .	Philadelphia,	Penna.	24
Saws, .	Pearson Crosby, .	City of	N. Y.	10
Scaffolds,—Builders' .	John K. Lemon, .	Toledo,	Ohio,	10
Scales, .	H. N. and J. C. Bill,	Willimantic,	Conn.	3
Scissors, .	Francis B. Bowman,	Waltham,	Mass.	3
Seed Planters, .	John Robinson, .	Sharptown,	Md.	17
Seeding Harrows, .	William Finlay, .	Schoolcraft,	Mich.	10
——— Machines,	James F. Gyles, .	Gilmer towns'p,	Ill.	3
——— .	Alonzo R. Root, .	Canton,	Mo.	3
———	A. and R. B. McElroy,	Waupun,	Wis.	3
——— .	F. Chamberlin, .	Berlin,	"	10
———	Thomas Lindsey, .	Lincoln,	Ill.	10
———,—Broadcast	John Barnes, .	Lima,	N. Y.	24
Sewing Machines, .	Thomas Newlove, .	Chicago,	Ill.	3
———	Warren Millar, .	"	"	10
——— .	Allen & Molyneux, .	Bordentown,	N. J.	17
———,—Driv. mech.	Jonas Perkins, .	Braintree,	Mass.	17
——— Machine,—Stitch of a	J. S. McCurdy, .	Brooklyn,	N. Y.	24
——— Machines,—Tension ap.	C. G. Cross, .	Chicago,	Ill.	17
——— Mach. needles,—thread'g	John Stevens, .	City of	N. Y.	3
Sextant, .	Louis Daser, .	Washington,	D. C.	17
Sheet Metal,—Cutting	John Waugh, .	Elmira,	N. Y.	24
Shingle Machines,—Tilt'g bolt	Tyrannus P. Butterfield,	Indianapolis,	Ind.	3
Shirt Stud, .	Henry Simon, .	Providence,	R. I.	10
Shoemakers' Awls, .	B. J. Lane, .	S Framingham,	Mass.	17
Show-case Doors, .	Daniel Barclay, .	Chicago,	Ill.	24
Skates, .	Bradford Stetson,	Uxbridge,	Mass.	24
Slate,—Artificial .	Thomas J. Mayall, .	Roxbury,	"	10
——— Roof,—Laying .	Isaac Mott, . .	Glenn's Falls,	N. Y.	10
Sofa Bedstead, .	William H. Tendler,	Cambridge,	Mass.	10
Sowing Machines, .	W. W. Williams,	Elizabeth City,	N. C.	3
Staging-supporter for mechanics,	Azel Reynolds, Jr., .	N. Bridgewater,	Mass.	17
Steam Boiler, .	Stone and Whipple,	Roxb'y&Boston,	"	10
——— .	E. W. Tarbell, .	Boston,	"	17
——— .	B. H. Wright, .	Rome,	N. Y.	24
——— Boilers, .	James Montgomery, .	Baltimore,	Md.	17
———,—Feed Water	Thomas Snowdon,	Pittsburgh,	Penna.	3
———	C. and G. M. Woodward,	City of	N. Y.	10
———	Henry Giffard, .	Paris,	France,	24
———	G. W. Rains, .	Newburgh,	N. Y.	24
———,—Gauge, &c., for	James Montgomery,	Baltimore,	Md.	24
———,—Spark-extin.	D. S. Harris, .	Galena,	Ill.	10
———,—Test'g floats	George W. Lane,	Boston,	Mass.	3
——— Carriages, .	J. V. Merrick, .	Philadelphia,	Penna.	17
——— Engines, .	Frank Douglas, .	Norwich,	Conn.	3
——— .	Ormrod C. Evans, .	City of	N. Y.	10
———,—Gov. Valves of	P. L. Weimer, .	Lebanon,	Penna.	3
———	Edward Armstrong, .	Pittsburgh,	"	3
———	P. L. Weimer, .	Lebanon,	"	17
——— Generators, .	R. E. Rogers, .	Philadelphia,	"	17
——— Trap Valve,	John Avery, Jr., .	City of	N. Y.	10
——— .	Daniel Lee, .	Boston,	Mass.	17
Steel,—Manufacture of	A. K. Eaton, .	City of	N. Y.	3
Steering Apparatus, .	William W. Huse, .	Brooklyn,	"	10
Stones,—Machines for Breaking	E. W. Blake, .	New Haven,	Conn.	17
———,—Crushing .	G. H. Wood, .	Green Bay,	Wis.	24

Stones,—Stamping & Crushing	Jeremiah Stever,	Bristol,	Conn.	3
Stoves, . .	W. J. Cantilo, .	Philadelphia,	Penna.	24
———,—Cooking	Joseph C. Henderson,	Albany,	N. Y.	3
Straw-cutters, .	C. B. Mallory, .	Fredonia,	"	3
——— .	Root and Lloyd, .	Muncy,	Penna.	17
Stump Extractors, .	L. C. English, .	Canton,	N. Y.	17
———	Caleb Bates, .	Kingston,	Mass.	17
Sugar Cane,—Crushing	Theodore Grundman,	Freeport,	Ill.	17
——— Holder & Distributor,	Thomas Lewis, .	Malden,	Mass.	3
——— Juices,—Evaporating	Seth W. Eells, .	Mansfield,	Ohio,	10
——— Mills, .	G. W. L. Hazen,	Indianapolis,	Ind.	17
———,—Crushing Rollers	Philetus W. Gates, .	Chicago,	Ill.	10
Sweeping Streets, .	Robert A. Smith,	City of	N. Y.	10
Swing,—Portable	L. K. Selden, .	Haddam,.	Conn.	24
Tanning, .	David Needham,	Oskaloosa,	Iowa,	10
———,—Concen. Extracts	James Connell, .	Port Huron,	Mich.	10
———,—Method of .	M. A. Bell, .	Rushford,	N. Y.	24
Teeth,—Fastening Artificial	A. M. and J. L. Asay,	Philadelphia,	Penna.	3
Telegraph Wires,—Insulating	John M. Batchelder,	Cambridge,	Mass.	10
Temples for Looms, .	J. H. Woodward, .	Nashua,	N. H.	24
Thread and Yarn,—Manufac. of	S. M. Allen, .	Niagara Falls,	N. Y.	17
Thills to Vehicles,—Attaching	L. W. Boynton, .	City of	"	3
Tire,—Upsetting .	Leonard Kile, .	Williamsfield,	Ohio,	10
Tobacco Presses, .	E. S. Collins, .	Aspen Wall,	Va.	17
Tombstones, .	Thomas Windell,	New Albany,	Ind.	24
Trap,—Animal .	Levi W. Buxton, .	Nashua,	N. H.	24
Traveling Bags, .	T. R. Dunham, .	Newark,	N. J.	24
Trip Hammer, .	David Howell, .	Louisville,	Ky.	10
Valves, .	Joseph Higginbotham,	Philadelphia,	Penna.	10
Vapor Burners, .	Edward H. Anderson,	Easton,	Md.	3
——— .	Hopkins & Anderson,	"	"	3
——— .	Oscar F. Morrill, .	Boston,.	Mass.	3
——— Lamps, .	Henry Johnson, .	Washington,	D. C.	17
Varnish, .	André Sabatier, .	City of	N. Y.	10
Veneers,—Machines for Cutting	David Donald, .	" .	"	17
——— .	Koch and Stoeckel, .	"	"	24
Vessels of Sheet Metal,—Form'g	J. B. Jones, .	Brooklyn (E D),	"	17
Voting Register, .	J. W. Wetmore, .	Erie,	Penna.	3
Vulcanized Rubber,—Restoring	C. F. E. Simon, .	Washington t'n,	N. J.	10
Walls,—Building Concrete	Elizur E. Clark, .	New Haven,	Conn.	3
———	" .	"	"	24
Warming Apparatus,—Draft in	Brown and Ellis, .	City of	N. Y.	3
Washboard, .	Joseph Keech, .	Waterloo,	"	10
——— .	Edward Hatfield, .	Brownsville,	Penna.	10
Washing Machine, .	Burgan B. Wescott,	Camden,	Ind.	10
———	Patterson and Morell,	Woodbury,	N. J.	10
——— .	Josee Johnson, .	City of	N. Y.	10
———	Sharp and Mood,	Ithaca,	"	10
——— .	H. C. Smith, .	Cleveland,	Ohio,	10
———	C. K. Williams, .	Haddonfield,	N. J.	17
——— .	G. W. Tolhurst, .	Liverpool,	Ohio,	24
Water Elevators,	James Aldrich, .	Washington,	D. C.	10
Well Buckets, .	Daniel D. Farnham, .	Johnstown Cen.	Wis.	3
Wheels for Artillery Carriages,	John D. Murphy,	Baltimore,	Md.	3
Whiffle-trees,—Self-detaching	S. D. Bowker, .	Geneva,	Ohio,	17
Window-blind Slat Machine,	H. W. Farmer, .	Poultney,	Vt.	24
Window-sash Supporters,	J. W. Briggs, .	Cleveland,	Ohio,	17
Window Sashes, .	McCoy and Muth,	Wheeling,	Va.	24
———,—Supporting	David C. Lyall, .	City of	N. Y.	10
Wind-mills, .	E. F. M. Fletcher,	Georgia Plains,	Vt.	17
Wood,—Polishing	George Munger, .	New Haven,	Conn.	17
Wooden Ware,—Making	Ansel Howard, .	Readsborough,	Vt.	10
Writing Desk,—Reading and	Carl Pretsch, .	Trenton,	N. J.	10

EXTENSIONS.

Curry-combs,	William Wheeler,	New Britain,	Conn.	17
Door Locks,	Joshua H. Butterworth,	Dover,	N. J.	3
Hat-bodies,—Making,	Eliza Wells,	City of	N. Y.	24
———,—Manufacturing	"	"	"	24
Printing Presses,—Checking	Alva B. Taylor,	"	"	3
Saw-mills,	Thomas J. Wells,	"	"	3
Stoves,—Registers of	Washburn Race,	Seneca Falls,	"	10
Telegraphs,—Electro-magnetic	S. F. B. Morse,	Poughkeepsie,	"	17
Telegraph,—Mag. Letter Print'g	R. E. House,	Binghampton,	"	24

ADDITIONAL IMPROVEMENTS.

Canal Boat Propellers,	Robert Cartwright,	Ithaca,	N. Y.	3
Coffee Pots,	H. P. Gatchell,	Ravenna,	Ohio,	3
Harvesters,—Cutters for	John Gore,	Brattleboro',	Vt.	10
Windlasses,—Ship's	James Emerson,	Boston,	Mass.	3

RE-ISSUES.

Boiler-feeder,—Automatic	S. B. Hunt,	City of	N. Y.	24
Enameling Moldings,	Robert Marcher,	"	"	3
Folding Paper,	George K. Snow,	Watertown,	Mass.	3
Knitting Machines,	Clark Tompkins,	Troy,	N. Y.	24
Looms for Figured Fabrics,	Moses Marshall,	Lowell,	Mass.	24
Manure Excavators,	Abraham R. Hurst,	Chambersburg,	Penna.	3
Matrices,—Mode of constructing	J. C. Smith,	Philadelphia,	"	10
Planing Lumber "out of Wind,"	S S Gray & S A Woods,	Boston,	Mass.	17
Railroads,—Dispensing switches	Wm. Wharton, Jr.,	Philadelphia,	Penna.	3
Stoppers for Bottles,—Glass	T. R. Hartell,	"	"	24
Stoves,—Coal	C. Eddy and J. Shavor,	Troy,	N. Y.	10
Straw-cutters,	Warren Gale,	Chicopee Falls,	Mass.	3

DESIGNS.

Andirons, (2 cases,)	Samuel Boyd,	City of	N. Y.	3
Carpets,	David McNair,	Roxbury,	Mass.	3
———,	Francis J. Pierce,	Lowell,	"	3
Coffins,	James C. Karr,	Williamson co.,	Tenn.	3
Cooking Range,	J. Martino & J. Horton,	Philadelphia,	Penna.	10
Fire-dogs (6 cases,)	Theodore W. Lillagore,	"	"	3
Floor Cloth,	Jeremiah Meyer,	City of	N. Y.	24
——- Oil Cloth,	J. B. Virolet,	"	"	24
Ice Pitchers,	George W. Smith,	Hartford,	Conn.	3
Paint Cans, (3 cases,)	W. L. Gilroy,	Philadelphia,	Penna.	24
——— Vessels,	"	"	"	24
Spoon Handles,	John Polhamus,	City of	N. Y.	10
Lead Pencils,—Stamping on	Joseph Rosenthal,	"	"	3
Stoves,	N. S. Vedder,	Troy,	"	24
———,—Parlor	Isaac De Zouche,	St. Louis,	Mo.	24
Trade-marks for Lead Pencils,	Joseph Rosenthal,	City of	N. Y.	3
Trade-mark for Neuralgic Pills,	Samuel Armitage,	St. Louis,	Mo.	3
Water Coolers,	Charles Muller,	City of	N. Y.	3

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 21, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President, } Present.
Isaac B. Garrigues, Recording Secretary, }

The minutes of the last meeting were read and approved.

Donations to the Library were received from the Royal Astronomical Society, The Chemical Society, and the Institute of Actuaries of London; the Oesterreichischen Ingenieur-Vereines, Vienna, Austria; the Regents of the University of New York, Albany, N. Y.; F. H. Storer, Esq., Cambridge, Mass.; the Ohio Mechanics' Institute, Cincinnati, Ohio; the State Agricultural Society, Madison, Wisconsin; and from Dr. Alexander Wilcocks, Prof. John F. Frazer, and the American Philosophical Society, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (5) were proposed, and the candidates proposed at the last meeting (4) duly elected.

In compliance with a request from the Committee on Meetings, the President gave a brief description of the large balloon of Professor Lowe, with which he proposes to attempt a transatlantic voyage. Its dimensions were stated to be 110 feet in horizontal diameter, and about 120 in height; the cubical capacity being 700,000 cubic feet. The idea of the æronaut is to inflate with about one-half the quantity of gas the balloon will hold, so as to allow room for expansion as the machine rises. The buoyancy of the ordinary coal gas being about 40 lbs. to the thousand feet, the buoyant power with this degree of inflation will be about 14,000 lbs., of which about 5000 lbs. will be required to sustain the balloon and trappings, including a life-boat, with sails, &c. The remaining floating power beyond the weight of passengers and provisions, will be balanced by portable ballast, which is to be thrown overboard as occasion requires. Prof. Lowe expects to rise to the height of three miles, and there travel East-by-North in the prevailing upper current of the atmosphere, which he supposes to have a velocity of nearly 100 miles an hour, and will therefore waft him across the Atlantic in less than two days.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Ritchie's Rhumkorff's Induction Apparatus.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"An Improvement on Rhumkorff's Induction Apparatus," by E. S. Ritchie, of Boston, Massachusetts,

REPORT:—That, as it appears from the description of the apparatus by Mr. Ritchie, hereto annexed; his apparatus differs from those made before him in the following particulars:—

In making the primary helix of greater diameter, and of larger wire; the iron core is made longer than the helix; the primary helix is insulated more thoroughly from the secondary, by a glass bell with a broad flanch below, on which the secondary coil rests; the secondary coil is wound differently, in place of winding in successive helices, it is wound by spirals alternately outward and inward, beginning with the base. In this way, it will be seen that between any two points nearly in contact, there is less difference of intensity than in the old mode, and thus less thickness of insulating material is required, and a greater length of coil can be put within the inductive influence. This secondary helix is also more carefully covered with insulating material; the condenser (which is Fizeau's invention) is divided into three sections, so that the power of the instrument may be modified by the use of one, two, or all of the parts. The interrupter is modified and placed under the control of the operator, by which a more sudden and slower brake can be made, and thus the power of the instrument increased.

The Committee have experimented upon the apparatus constructed by Mr. Ritchie, for the Department of Arts of the University of Pennsylvania, and they find that this apparatus excited by three cells of a carbon battery, the zincs of which are five inches in diameter and eleven inches in height, is capable of giving a spark of eleven inches in length; while, so far as the Committee is aware, no spark over three inches has ever been obtained, either by Rhumkorff or his English improver, Hearder, until after an instrument constructed by Mr. Ritchie on this plan had been sent to England; and even now a spark of the same length from one of those instruments requires much larger batteries than those of Mr. Ritchie.

The Committee regard the modifications which Mr. Ritchie has introduced into the apparatus as improvements, and his mode of winding the coil, especially, as novel, ingenious, and highly valuable; and believing that this apparatus is destined to be of great importance in the arts, owing to the economy, simplicity, and energy with which it generates a powerful electric current; and regarding some of the modifications of Mr. Ritchie to be original and of great utility, they recommend the award of the *Scott's Legacy Medal and Premium* to Mr. E. S. Ritchie, of Boston, for his Improved Rhumkorff's Induction Apparatus.

By order of the Committee,

WM. HAMILTON, *Actuary*.

Philadelphia, May 10th, 1860.

Description of Ritchie's Rhumkorff's Induction Apparatus.

The primary helix is made of No. 9 copper wire, which is about $\frac{1}{8}$th of an inch in diameter, insulated, and wound in three courses; its length is about 180 feet, and it encloses a bundle of carefully annealed

iron wire of about 1½ inches in diameter. Wires are used instead of a solid bar as they can be more readily and perfectly annealed. One end of the wire of the primary helix passes directly to a pole cup for connecting with the battery; the other end of the wire connects with the pillar, *b*, carrying a screw capped with platinum. This is in contact with a similar platinum cap on a spring, supported upon a pillar, *c*. This pillar connects with the other pole cup. When the battery is attached, the iron bundle or core becomes a powerful electro-magnet, but is demagnetized by breaking the circuit, by depressing the spring, separating the platinum caps. This is called the "interrupter," or "break-piece." The hammer and ratchet wheel are to effect this interruption at pleasure. Over this primary is placed for insulation a bell glass, and over the bell glass is placed the

Secondary helix.—This is made of insulated copper wire of one-eightieth of an inch diameter, covered with silk, and of about sixteen miles in length. The terminals are conducted for convenience to glass pillars furnished with discharging rods.

+ AND — BATTERY WIRES.

a, Primary Helix. One wire connects with + pole; the other passes to pillar (*b*). The circuit is completed through pillar (*c*) to the other pole cup.

b connects directly with knob of condenser, by a wire, at (*d*).

c connects through screw *f* with knob of condenser; or three screws at *f* bear upon 3 knobs (*g*), which each has a separate bundle of condensers. The alternate sheets of all are united at the opposite pole at *d*.

Thus far the instrument is in principle the same that has been in use for years, though incapable of throwing a spark in the air across an interval. But connected with the interruptor is a

Condenser, due to Fizeau. This is simply a Leyden jar of great surface, and is made of oiled silk with coatings of tin foil. The silk is in sheets, about 18 by 10 inches, piled up with intervening sheets of foil, a little smaller in size. Every other sheet of foil is connected by a small ribbon of foil, extending out on one side, while the alternate sheets of foil are similarly connected by ribbons, extending on the opposite side. The whole pile is enclosed for convenience in a box, and placed within the basement. The two bundles of ribbons of foil, connect with two pieces of metal coming through the cover of the box; the whole may be considered as a battery of Leyden jars, and

these metallic pieces are the discharging knobs. When the box is in place, these knobs connect with the two pillars above mentioned; so that each cap of platinum of the interrupter is in metallic connexion, the one with one side of the Leyden jar, the other cap with the opposite side of the Leyden jar.

On the opposite page is a drawing which will show the connexions.

I will now give the particulars in which my instrument differs from those previously constructed.

I use a primary helix of larger proportionate diameter and of larger wire. The iron core I make much longer than either the primary or secondary helix (these are of equal length); the core I make from 50 to 100 per cent. longer. The intensity of an electro-magnet being greatest at the middle, I thus obtain a more intense magnetic force, and the intensity and volume of the induced current is much increased.

I insulate the two helices much more perfectly. Glass tubes have been used, but as the discharges took place through the iron core, I closed one end, making the tube into a bell glass, and still further added to its effect by making a flanch project from the lower edge.

In all previously constructed instruments, the secondary helix was wound longitudinally as a spool of thread, each course or stratum being insulated from the next by gutta percha or other material; but after many courses are thus laid, the intensity becomes sufficient for the spark to break through or pass around from the outer to the inner stratum, and consequently the limits of power were soon reached, and the longest spark obtained was not over three inches. Rhumkorff had then obtained but about half an inch with a single instrument. Much greater intensity in this form is impossible, as each insulation must be increased proportionately in thickness, and this would carry the outer strata beyond the influence of the iron core. I devised a mode of winding the helix which obviated this difficulty. I wind my helix in strata perpendicular to the helix, and wind it as a sailor coils a rope upon the deck: beginning with a small circle, he winds arounds this his rope until the circle is as large as desirable; he lays a turn upon this last one, and commences a second stratum or layer, winding now each turn within the last, until he reaches the size of circle he commenced with; again, a third stratum upon this.

I build my coil in the same manner. I make a cylinder of gutta percha, with a flanch or head as large in diameter as the coil is to be. Each stratum is parallel with the head and between each is an insulation; but as I now only desire to prevent the spark from leaping from the wire where one layer is commenced to the wire where the next lies upon it (and the length is but a few hundred feet), a very thin insulation is enough, and a disc of oiled silk is sufficient. The helix can be built up indefinitely, as I make the section no deeper than that the intensity obtained in each stratum equals its thickness with the thickness of insulation. Consequently, if the spark cannot leap further than from layer No. 1 to No. 2, it cannot leap to the 3d, or the 10th, or the 100th, because the *distance* from the 1st to the 3d and

10th, &c., is proportionately greater—when wound longitudinally it is otherwise. A sufficient insulation may protect No. 1 from No. 2 course, but No. 10 has ten times the intensity, and is necessarily brought very near No. 1, and the insulation fails. In this case the coil is ruined. But, as I wind it, if battery force is put on enough to make the spark leap its entire length, it does no harm.

I also cover the helix outside, sometimes entirely and sometimes only the lower portion, with gutta percha.

In previously-constructed instruments, the interrupter used was De La Rive's automatic break-piece. I found this far too rapid, that *time* was required, and that for different results a very varied rate is requisite; also, that a *sudden* break is more effective. I devised the interrupter to meet these requirements, and place the discharges more in control of the operator. By my interrupter, a longer and a far more voluminous discharge is produced.

I divide the condenser into two or three parts, and connect each through a screw, so that either or all may be used, or all may be disconnected.

To introduce these changes, of course the entire form and arrangement of parts are different from all others.

So far as I have information, not until after I had published my mode of constructing this instrument and had sent one to the order of Gassiot, of London, throwing over twelve inches, had any been made of over three inches of spark.

I respectfully submit the instrument with these explanations to the Committee on Science and the Arts of the Franklin Institute.

E. S. Ritchie.

Boston, Dec. 10, 1858.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A. M.

May.—The month of May, 1860, was distinguished for its thunder storms, and the number of days on which rain fell. There were no less than eight thunder storms at Philadelphia during the month, though but little damage resulted from them here. Those of the 21st and 30th of the month, however, were very violent and destructive; the former in Ohio, and the latter in the north-western part of Pennsylvania.

Rain fell at Philadelphia on nineteen days of the thirty-one, showing a greater number of rainy days than has ever before been noticed in the month of May. In May, 1858, rain fell on eighteen days, and in 1853 and 1854, on fifteen days. The average number of rainy days for the month of May, during nine years, is thirteen.

The mean temperature of the month was less than 1° above the average, while it was about half a degree colder than May, 1859.

The warmest day of the month was the 25th, of which the average temperature was 74·3°. The 7th, however, was almost as warm, having an average temperature of 74·0°. The thermometer was highest on the 7th, reaching 90° about 2½ P. M. The thermometer was lowest on the morning of the 1st, when it indicated 44°. The 1st was also the coldest day, the average temperature being 47·7°.

The barometer was highest (30·050) on the 12th, and lowest (29·479) on the 19th of the month. There was a period of low barometer, extending from the 17th till the 24th, reaching the minimum about 4 P. M. on the 19th, a day or so before the storm so destructive to life and property occurred in the west. A similar, though less marked fall in the barometer occurred on the 30th and the 31st of the month.

An inspection of the following table will show another illustration of the fact alluded to in the *Journal* for the last month in relation to the close coincidence of the average barometric height for the month, with that for 9 P. M. During last May the average height for 9 P. M. was but ·005 of an inch higher than the average for the month. During the month of May, 1859, it was but ·002 of an inch higher; and for the same month, for nine years, it stood only ·003 of an inch higher at 9 P. M. than the monthly average for the same period.

A Comparison of some of the Meteorological Phenomena of May, 1860, with those of May, 1859, and of the same month for nine years, at Philadelphia.

	May, 1860.	May, 1859.	May, 9 years.
Thermometer.—Highest,	90°	87°	90°
" Lowest,	44	44	35
" Daily oscillation,	17·20	19·70	16·60
" Mean daily range,	5·20	5·70	5·60
" Means at 7 A. M.,	59·66	59·66	58·47
" " 2 P. M.,	71·03	72·24	69·79
" " 9 P. M.,	61·57	62·06	61.61
" " for the month,	64·09	64·65	63·29
Barometer.—Highest,	30·050 in.	30·176 in.	30·338 in.
" Lowest,	29·479	29·512	29·386
" Mean daily range,	·100	·111	·121
" Means at 7 A. M.,	29·828	29·894	29·843
" " 2 P. M.,	29·787	29·853	29·809
" " 9 P. M.,	29·815	29·876	29·830
" " for the month,	29·810	29·874	29·827
Force of Vapor—Means at 7 A. M.	·395 in.	·361 in.	·361 in.
" " " 2 P. M.	·421	·383	·383
" " " 9 P. M.	·420	·393	·383
Relative Humidity at 7 A. M.	76 per ct.	70 per ct.	73 per ct.
" " 2 P. M.	57	50	53
" " 9 P. M.	76	69	69
Rain, amount in inches,	3·589	1·946	4·196
Number of days on which rain fell,	19	11	13
Prevailing winds,	N. 59°2′ E.·070	S.7°36′ W. ·090	N71°12′ W·099

The amount of rain which fell during the month was nearly twice as much as that which fell in May, 1859, but is still below the average for nine years. The force of vapor and the relative humidity, as will be seen by an inspection of the table, were both considerably higher than usual.

SPRING.—The Spring, consisting of the months of March, April, and May, was one degree warmer than the average for the last nine years, but a degree and a half cooler than the Spring of 1859.

The barometric observations are almost the same as those for the Spring for nine years, but are considerably higher than for the Spring of 1859. The closeness of the 9 P. M. observations to those for the quarter, are also very apparent in the following table of comparisons.

The number of days on which rain fell was more than the average, although the amount of rain and melted snow which actually fell was three inches less than the average, and four and a half inches less than fell during the Spring months of last year.

A Comparison of the SPRING *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Spring, 1860.	Spring, 1859.	Spring for 9 years.
Thermometer.—Highest,	90°	87°	90°
" Lowest,	25	20	4
" Daily oscillation,	18·10	17·40	15·90
" Mean daily range,	6·00	6·00	6·07
" Means at 7 A. M.,	47·26	49·04	46·59
" " 2 P. M.,	59·98	61·23	58·19
" " 9 P. M.,	51·07	52·78	50·54
" " for the spring,	52·77	54·35	51·77
Barometer.—Highest,	30·303 in.	30·360 in.	30·522 in.
" Lowest,	29·319	29·215	28·884
" Mean daily range,	·133	·174	·164
" Means at 7 A. M.,	29·835	29·798	29·829
" " 2 P. M.,	29·779	29·755	29·785
" " 9 P. M.,	29·813	29·780	29·813
" for the spring,	29·809	29·778	29·809
Force of Vapor—Means at 7 A. M.	·259 in.	·258 in.	·253 in.
" " " 2 P. M.	·277	·274	·273
" " " 9 P. M.	·277	·280	·273
Relative Humidity—Means at 7 A. M.	73 per ct.	69 per ct.	73 per ct.
" " " 2 P. M.	50	49	53
" " " 9 P. M.	68	66	68
Rain and melted snow,	8·558 in.	14·117	11·727
No. of days on which rain or snow fell,	42	38	37
Prevailing winds,	N.76°26′W·119	N.76°32′W.·148	N.73°32′W·198

Abstract of Meteorologi[illegible] April, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties,
[illegible]e Committee on Meteorology of the Franklin Institute.

PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 60 feet. Prof. J. A. KIRKPATRICK, Observer.

1860. April.	Barometer. Mean.	Barometer. Mean daily range	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor 2 P.M.	Relative humidity, 2 P.M.	Rain.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
1	29·891	·224	55·0	22	7·5	·239	59	0·073	S W.
2	29·675	·284	35·7	14	19·3	·081	81		N W.
3	29·684	·111	43·3	25	8·3	·182	34		S.
4	29·466	·218	55·3	16	12·0	·394	76	0·083	S.
○ 5	29·560	·100	54·3	21	5·0	·142	22	0·145	S W.
6	29·761	·221	49·3	16	5·0	·173	36		N W.
7	30·035	·254	46·8	21	2·5	·161	35		(var.)
8	29·776	·258	54·7	21	7·8	·472	58	0·387	S W.
9	29·690	·097	57·7	12	3·0	·500	88	0·645	N N E.
10	29·880	·189	45·0	13	12·7	·261	84	} 1·216	E.
11	29·712	·200	45·3	10	3·0	·282	78		N W.
☾ 12	29·894	·184	49·8	23	5·5	·172	33	0·008	W N W
13	29·808	·090	50·0	16	3·5	·150	33		W S W.
14	29·796	·060	41·3	22	3·7	·196	74	0·080	S W.
15	30·071	·273	39·8	18	6·6	·113	38		N W.
16	29·978	·098	41·7	10	3·2	·264	91	0·450	N E.
17	29·707	·180	50·7	32	19·0	·403	59		S W.
18	30·282	·464	45·7	22	12·0	·126	31		N N W.
19	30·193	·111	51·3	25	3·7	·197	35	0·060	S W.
20	29·830	·363	54·7	12	5·7	·377	81	0·067	S W.
● 21	29·618	·212	62·7	33	12·7	·481	47		(var.)
22	29·716	·096	44·0	10	18·7	·223	69	0·423	N E.
23	29·737	·041	51·8	15	7·8	·279	62		W S W.
24	29·766	·046	47·8	15	4·0	·150	33		N W.
25	29·716	·050	42·5	18	5·3	·230	63	0·060	W S W.
26	29·963	·147	44·7	23	4·8	·110	29		W N W
27	30·044	·180	40·5	23	4·8	·161	36		(var.)
☽ 28	30·073	·045	52·8	17	3·3	·185	37		(var.)
29	29·976	·097	53·7	17	3·5	·119	21		S E.
30	29·925	·061	54·5	23	2·8	·163	27		N N E.
Means	29·824	·166	49·5	19	7·4	·234	60	[illegible]	N 88½ W.

CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.

1860. April.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	28·834	48·3	10·0	·309	64	0·160	W.
2	29·169	34·0	14·3	·093	41		W.
3	29·062	45·7	11·7	·116	36		(var.)
4	28·851	49·7	6·0	·362	87	0·285	(var.)
5	29·001	53·7	6·0	·160	56		W.
6	29·330	49·3	5·3	·157	33		W.
7	29·440	51·3	5·7	·163	29		S W.
8	29·182	55·7	4·3	·239	66	0·626	E.
9	29·184	57·0	11·3	·476	70	0·068	(var.)
10	29·372	49·7	7·3	·269	67	1·400	E.
11	29·236	51·0	5·3	·236	70	1·305	W.
12	29·416	50·3	2·7	·203	42		(var.)
13	29·376	47·0	4·0	·110	26		W.
14	29·315	44·0	4·3	·125	40		W.
15	29·530	42·0	3·4	·090	29		W.
16	29·383	53·7	11·7	·260	78		W.
17	29·345	54·0	14·3	·256	30	0·102	W.
18	29·607	46·7	9·3	·157	33		W.
19	29·673	54·3	7·7	·191	41		W.
20	29·296	66·3	9·3	·416	57		E.
21	29·086	64·3	15·7	·462	44	0·066	W.
22	29·154	52·7	15·0	·296	65		(var.)
23	29·224	52·0	2·7	·229	44		W.
24	29·286	43·3	3·7	·118	25		W.
25	29·194	43·3	4·0	·125	40		W.
26	29·490	44·7	4·0	·091	23		W
27	29·564	49·3	6·0	·129	27		(var.)
28	29·543	51·7	4·7	·204	45	0·065	W.
29	29·441	56·7	6·0	·176	30		E.
30	29·417	52·7	4·0	·150	23		E.
Means	29·293	50·5	7·6	·215	45	3·967	West.

INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.
FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height, 1000 feet. J. H. BAIRD, Obs.

1860. April.	Indiana: Thermometer. Mean.	Indiana: Thermometer. Mean daily range.	Indiana: Prevail'g winds.	Freeport: Thermometer. Mean.	Freeport: Thermometer. Mean daily range.	Freeport: Prevailing winds.
	°	°	Direc.	°	°	Direc.
1	31·7	22·0	N W.	29·0		(var.)
2	46·0	14·3	(var.)	28·7	10·3	N E.
3	50·7	5·7	(var.)	47·3	18·7	?
4	42·3	8·3	S W.	50·0	7·3	S W.
5	47·3	6·3	N W.	45·0	5·7	(var.)
6	52·0	11·3	S E.	40·0	5·0	W.
7	60·3	8·3	S W.	53·3	13·3	N E.
8	64·7	7·0	S E.	64·0	10·7	W.
9	58·7	6·0	S E.	62·0	6·7	N E.
10	43·0	16·7	(var.)	63·6	8·3	S W.
11	44·7	11·0	N W.	41·3	22·0	(var.)
12	40·7	4·7	W.	46·7	9·3	S W.
13	36·3	10·3	N W.	43·3	8·3	(var.)
14	30·0	14·7	E N E.	37·3	6·0	(var.)
15	52·0	13·0	E.	38·0	9·3	N E.
16				52·0	14·0	(var.)
17				55·7	15·7	W.
18	55·0		(var.)	46·3	14·0	(var.)
19	62·3	10·7	S E.	55·7	9·3	(var.)
20	66·0	13·7	S W.	65·0	9·3	S W.
21	60·7	2·0	(var.)	63·7	4·3	(var.)
22	56·7	10·0	N W.	53·3	10·0	N W.
23	45·3	11·3	N W.	43·7	9·7	N W.
24	39·0	6·3	N W.	37·7	6·0	(var.)
25	36·3	3·7	N W.	36·7	2·7	W.
26	34·0	4·7	N W.	37·3	5·0	(var.)
27	41·7	7·7	N W.			?
28	49·3	7·7	S E.	51·7		?
29	54·3	6·0	E.	57·7	6·0	N E.
30	56·7	9·6	S E.	60·3	4·0	S W.
Means	49·0	9·3	N 70° W.	48·6	9·3	N 62½° W.

Abstract of Meteorological Observations for April, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

	...rg, Adams Co. ... N. Long. 77° 18′ W. Prof. M. Jacobs, Obs.						Harrisburg, Dauphin Co. 40° 18′, N. 76° 50′, W. Ht., 300 ft. John Heisely, M.D., Obs.				
	Barom.	Thermom.		Rain.	Pre-vail'g winds.	Barom.	Thermom.		Rain and Snow.	Pre-vail'g winds.
	Mean.	Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.		
			°	Inch.	Direc.	Inch.	°	°	Inch.	Direc.
			11·0	0·160	(var.)	29·257	60·0	10·7		S W.
			14·3		N.	29·561	37·0	13·0		N W.
			18·0	0·050	N E.	29·482	46·3	9·3		S W.
			7·0	0·150	S S W.	29·205	52·7	6·7	0·135	N E.
			7·3		S W.	29·379	55·0	1·0	0·150	S W.
			5·3		N W.	29·719	48·7	4·3		N W.
			6·7		S.	29·885	49·7	5·0		S E.
			9·7	0·400	S.	29·616	50·7	5·7	} 1·564	(var.)
			8·0	0·075	N N E.	29·581	60·0	9·3		N E.
			13·0	} 2·725	N E.	29·740	47·7	13·3	} 1·301	E.
			9·0		N E.	29·600	46·0	1·7		N.
			9·0		S W.	29·798	50·3	8·3		S W.
			5·3		N N W.	29·750	52·0	4·3		N W.
			7·7		N W.	29·683	44·7	7·3		(var.)
			6·3		(var.)	29·963	40·7	4·7		N.
			6·3	0·060	S S W.	29·845	42·0	5·3	0·074	E.
			17·0		W N W					(var.)
			14·3		N N W.	30·211	49·3			N W.
			3·7		(var.)	30·099	59·3	2·7		(var.)
			11·0		S W.	29·711	57·3	9·0		S W.
			14·0	0·235	(var.)	29·506	65·3	8·0	0·812	(var.)
			24·7		N E.	29·578	47·3	18·0		N E.
			2·3		W S W.	29·627	51·0	3·7		(var.)
			6·2		N W.	29·650	49·0	3·0		N W.
			6·0		N W.	29·506	41·7	6·3		N W.
			2·7		N W.	29·796	46·3	5·7		N W.
			7·3		S W.	29·965	49·0	3·7		W.
			4·9	0·070	(var.)	29·976	50·7	2·3		S E.
			6·7		N E.	29·861	60·3	5·7		N E.
			2·3		N E.	29·830	55·0	9·3		E.
Means	29·430	49·3	9·4	3·935	N 67° W.	29·706	49·9	6·9	3·624	N 14¼ W.

	Shamokin, Northumberland Co. 40° 48′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs.				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Height, 780 feet. S. Brugger, Obs.			
	Thermom.		Rain and Snow.	Pre-vail'g winds.	Thermom.		Rain and Snow.	Prevailing winds.
	Mean.	Mean daily range.			Mean.	Mean daily range.		
	°	°	Inch.	Direc.	°	°	Inch.	Direc.
	44·3	10·3	0·400	(var.)	43·0	19·0	0·600	S E.
	30·0	14·3		W.	32·3	12·0		N W.
	40·7	10·7		W.	43·0	10·7	0·180	S E.
	46·3	6·7		S E.	40·3	3·3	0·130	(var.)
	44·7	1·7		W.	46·0	6·3		W.
	43·3	8·0		W.	41·7	4·3		W.
	40·0	6·7		W.	45·0	13·0		(var.)
	45·3	12·3	0·500	(var.)	50·0	7·3	0·340	W.
	56·3	8·0	0·435	E.	58·3	8·3	0·400	(var.)
	44·3	12·0	0·348	E.	49·3	9·0	1·380	(var.)
	42·3	2·0	0·600	(var.)	44·0	5·3	0·620	(var.)
	43·7	11·0	0·035	N.	44·7	8·7	0·290	(var.)
	43·0	11·7	0·100	W.	43·3	8·0	0·035	N W.
	34·3	6·0	0·200	W.	30·3	8·0	0·140	N W.
	34·0	10·3		W.	36·0	10·0		E.
	40·0	6·0	0·232	E.	40·0	6·0	0·315	W.
	58·7	18·3		W.	55·7	15·7		N W.
	50·3	8·0		W.	43·3	12·3		(var.)
	46·7	6·3		S W.	48·0	8·7		S E.
	57·7	11·0	0·150	S.	56·7	8·7	0·280	W.
	62·3	4·7	0·532	N W.	54·7	8·0	0·780	W.
	41·7	20·7	0·100	S E.	51·0	13·7	0·300	(var.)
	47·3	5·7		E.	48·0	4·3	0·140	N W.
	49·3	4·0		(var.)	40·0	10·0		N W.
	32·7	10·7	0·208	S.	30·0	4·0	0·050	N W.
	30·3	7·3		N W.	35·3	3·3		N W.
	30·7	4·0		N W.	43·3	5·0		N W.
	44·7	4·0		E.	47·7	6·3		S E.
	52·3	7·7	0·011	E.	51·0	7·3		W.
	48·0	7·7		(var.)	49·0	4·0		W.
Means	45·1	9·6	4·140	S 73¾ W.	45·6	8·6	5·980	N 58° W.

	Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.						
	Barom.	Thermom.		Force of vapor.	Relative humidity.	Rain and Snow.	Pre-vail'g winds.
	Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.		
	Inch.	°	°	Inch	Per ct.	Inch.	Direc.
	27·206	45·0	11·7	·295	70	0·360	(var.)
	27·431	25·7	16·3	·101	50		(var.)
	27·279	45·3	10·0	·295	59	0·042	S W.
	27·133	44·3	8·3	·318	96	0·645	(var.)
	27·315	41·7	6·7	·196	52	0·195	W.
	27·023	30·7	2·7	·208	66		W N W
	27·667	46·7	8·3	·288	61		S S E.
	27·474	60·7	14·0	·463	51	0·346	W.
	27·511	60·3	7·7	·577	84	1·833	S.
	27·534	62·0	8·3	·375	93	} 1·687	S S E.
	27·579	41·3	10·7	·250	96		N W.
	27·676	45·3	12·0	·295	59	0·280	W.
	27·690	43·0	6·3	·168	56		W N W
	27·615	37·3	9·0	·234	61	0·004	N W.
	27·756	37·3	13·7	·188	56		(var.)
	27·602	52·0	14·7	·391	87	0·110	S W.
	27·092	58·7	17·3	·366	52		W.
	28·014	44·7	14·0	·217	50		(var.)
	27·867	46·0	4·0	·245	65		S.
	27·664	62·7	10·7	·531	63	0·030	W.
	27·497	62·3	7·0	·489	74		W.
	27·485	60·7	8·3	·443	65		W.
	27·673	46·0	13·7	·306	70		W.
	27·573	37·3	8·7	·196	68		W N W
	27·513	32·7	6·3	·147	78	0·032	W N W
	27·706	34·7	3·3	·132	55		W N W
	27·813	49·0	7·3	·230	56		
	27·772	47·7	8·7	·208	56		
	27·706	52·3	4·7	·255	46		
	27·677	50·7	4·3	·222	37		
Means	27·566	46·7	9·2	·290	66		

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CIVIL ENGINEERING.

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*On Coal-burning and Feed-water Heating in Locomotive Engines.**
By Mr. D. K. Clark, Assoc. Inst. C. E.

The object of the paper was stated to be, to discuss and compare the existing practice of coal-burning on railways. In burning coal, it was necessary to introduce air, in such quantity as to maintain a sufficiently high temperature in the furnace, and so to distribute it amongst the solid and the gaseous portions of the fuel, as to effect the thorough mixture of the air and the gases. After noticing the insufficiency of the ordinary locomotive boiler in its normal condition for the proper combustion of coal, the author described the methods introduced within the last two years for admitting air above the fuel, amongst the combustible gases. They were classed as—first, acting by currents of air, introduced through tubular or other openings in the sides of the fire-box, uniformly distributed over the surface of the fuel; secondly, by deflection of a body of air, introduced through the doorway, or elsewhere, upon and over the surface of the fuel; and, thirdly, by constructing large and spacious fire-boxes, with large grates and long runs. The third class, which was first in chronological order, was represented by the systems of Mr. M'Connell, Mr. Beattie, and Mr. Cudworth. Of these, the first and second were made with combustion chambers projected into the barrel of the boiler, and the second had, in addition, transverse midfeathers, and brick arches and tiles, for the better mixture of the elements, and the maintenance of the temperature; whilst the third consisted of an elongated fire-

* From Newton's London Journal, June, 1860.

box, with an inclined fire-grate sloping towards the tube-plate. In the application of the first and second classes of smoke-burners, the problem resolved itself into the following conditions:—The immediate and thorough intermixture of a plentiful but regulated supply of air, with the ascending smoke or combustible gases at or near to the surface of the fuel. Practically, it was found necessary for this object to operate from both the front and the back of the fire-box, with air-entrances, arches, and deflectors at the doorway, in various combinations. But such contrivances as dealt with air in bulk, though generally effective in preventing smoke, were stated to be usually attended by the escape of a considerable quantity of unconsumed air, through the flue-tubes, and a difficulty in keeping up steam at high speeds. The various forms of doorway deflectors were also stated to be objectionable, in facilitating, by their mode of action, the suction of particles of coal through the tubes, and the burning of the smoke-box, unless counteracted by an internal arch. The author had found by experience, that to burn smoke when the engine was working, it was sufficient that the air should be admitted at or near the surface of the fuel, by air-tubes distributed over the width of the fire-box, in the front and the back, without the aid of internal arches or deflectors. The draft of air through the front tubes was very strong when the engines ran ahead, carrying the currents into the middle of the fire-box, where they met the counter-currents from the back, effecting the mixture of the air and smoke, and preventing the suction of small coal through the tubes. But, in all systems applied to ordinary fire-boxes operating by means of the draft available in a locomotive engine, aided, when the blast was off, by the steam-jet in the chimney, range of power was wanting to overtake the extremes of intense ignition and rapid generation of smoke-making gases, immediately after the steam was shut off, or when fresh fuel was added; and to suit itself, also, to the quiet state of the fire, when the glow and excitement subsided, as well as to all the varying conditions of a locomotive furnace. The means of extending the range, volume, and power of the air-currents, and of adjusting them to the wants of the furnace, were supplied by the instrumentality of jets of steam, employed by the author as means of inducting and accelerating currents of air. The steam-nozzles, with the air-tubes towards which they were pointed, were like so many miniature blast-pipes and chimneys turned into the fire-box; and they possessed, relatively, the same power of urging and creating draft. By this method of steam induction, the air-currents were delivered with such precision and velocity, as to sweep the whole surface of the fuel, and forcibly to distribute the air amongst the gases.

In practice, it was only occasionally necessary to put the steam-jets in action when the engine was at work if the air-openings were sufficiently numerous, as the action of the blast alone drew a large supply of air through them into the fire-box. The time when the full inducting power of the jets of steam was in demand, was immediately on the steam being shut off from the engine, on drawing up to a station,

or otherwise. Then, the heat in the fire-box was fierce, and there was an extensive distillation of combustible gases, which were discharged as smoke from the chimney, unless met and consumed by the inducted currents above the fuel. The intenseness of the heat subsided rapidly, and the jets could be moderated as desired, and continued in action until the engine was again in motion. The indraft of air into the fire-box could be regulated by the use of slides or dampers over the air-openings. But, by so limiting the number of air-openings, and consequently the supply of air, as to prevent any material excess of supply when the fire was in ordinary condition, the dampers might be dispensed with in practice, without prejudice to the economy of fuel.

In making a general comparison between the various methods of coal burning without smoke, there was the difficulty of the diversity of circumstances as to time, fuel, engine, and duty to contend with. The performances of several engines burning coal, on different systems, and the same or similar engines using coke, had, however, been tabulated. It thus appeared that, of the three systems of extended fire-boxes, by Mr. M'Connell, Mr. Beattie, and Mr. Cudworth, with nearly equal gross weights of engine, tender, and train—100 to 116 tons—and at about the same speed, the consumption of coal was as follows:—

			Per ton gross.
Mr. M'Connell's,	35½ lbs. Hawkesbury coal	per mile,	or ·31 lb.
Mr. Beattie's (with cold water),	24 lbs. Griff & Stavely "	"	or ·235 lb.
Mr. Cudworth's,	26 lbs. coking coal,	"	or ·225 lb.

Of the systems of coal-burning grafted on the common fire-box, with passenger trains, comparative results were given of Mr. Douglas' with a doorway deflector on the Birkenhead Railway; Mr. Yarrow's with a brick arch and air-bars on the Scottish North-Eastern Railway; Mr. Connor's with a brick arch and door deflector on the Caledonian Railway; Mr. Frodsham's with a doorway deflector and steam roses in the fire-box, used by Mr. Sinclair on the Eastern Counties Railway; and the author's with air-tubes and steam-inducted currents, used by Mr. Cowan on the Great North of Scotland Railway. It appeared that, with eight to ten carriages, the following were the performances:—

	Gross Weight. Tons.	Gross Coal per mile. lbs.		Per ton gross. lb.	
Mr. Douglas, .	90	28·4	or	·32	Welsh.
Mr. Yarrow, .	86	25·7	or	·32	Fifeshire.
Mr. Connor, .	88	22·2	or	·26	Lanarkshire.
Mr. Frodsham,	93	23·3	or	·25	Stavely.
Mr. Clark, .	110	21·0	or	·19	Fifeshire.

Showing that, with the author's system, less coal was used with a heavier train than with any of the others. Similarly favorable comparisons were made in the working of goods engines.

The Great North of Scotland Railway, on which the author's sys-

tem was in full operation, was stated to contain long gradients, several of which varied from 1 in 100 to 1 in 150, with frequent curves; and the goods engines could take up these inclines 35 fully loaded wagons, 460 tons gross train weight, at 10 miles per hour.

In conclusion, it was stated that the author's system of smokeless coal-burning was distinguished from others by its simplicity, durability, efficiency, and simple management. There was no construction of any kind within the fire-box, and, consequently, no wear and tear by exposure to intense heat. At the same time that it commanded the entire range of the fire-box, it did not interfere with or impose extra labor in the management of the fire. The manipulation was simple; the air-tubes being placed at a sufficiently high level to command the surface of the fire at all times. The whole business of smoke-prevention was comprised in the occasional operation of the induction-jets, by means of a tap under the hand of the engine-driver, and the occasional aid of the chimney-blower, to carry off the products of combustion. By the proper use of this system, the fire might be "damped," or kept dull, when desired, where an engine had to wait at a station, without raising the pressure of the steam; as the forcible indraft above the fire might be made to prevent a draft through the fire, and consequently to check or to suspend the combustion of the fuel; conducing both to safety and to economy, and favorably contrasting with other systems, in all of which a powerful blower in the chimney was needed, when standing, incurring dangerous pressures and waste of steam.

In feed-water heaters, it was stated that little had as yet been done, except by Mr. Beattie, whose apparatus, though efficient as a heater, was found, it was believed, to be too complicated for general use, and difficult to keep in order. The author had recently introduced a simple and compact heater, in which the steam from the blast-pipe was projected into a short tube, in conjunction with the feed-water, which was delivered in a thin annular sheet around the steam-nozzle. In this short tube or chamber, the water was broken into spray by the steam; the steam was instantly condensed, and the water was raised to a high temperature, at or near the boiling point. It had given satisfactory results in a 20 H. P. stationary engine, and would shortly be applied to a locomotive engine. It was said to be well adapted for agricultural and other engines on wheels, where lightness and compactness were considerations of importance.

In the course of the discussion upon Mr. D. K. CLARK'S paper, "*On coal-burning and feed-water heating in locomotive engines*," it was remarked, that the plan of coal-burning advocated by the author seemed to be similar to that adopted by Mr. Jenkins, and which had been some time in use on the Lancashire and Yorkshire Railway, except that in the former jets of steam were employed to accelerate the currents of air. Mr. Jenkins' system consisted simply in making a certain number of the stays hollow instead of solid, through which the air was allowed to pass, and, mixing with the products of combustion, effected the prevention of smoke. Movable slides were fixed

on the outside, so that the apertures could be opened or closed at pleasure; and thus, either coal or coke could be burned in the same engine. The system could be applied to old engines, at an expense of a few pounds per engine, and was said to be simple and effective.

It was stated that the use of tubes through the sides, and in some cases the front, of the fire-box, for preventing smoke, had been tried nineteen years ago by Mr. Samuel Hall, the pioneer of surface-condensation, on the Midland Railway, and the same system was now practised on the Great Western Railway. The smoke, though then not entirely consumed, was believed to have been as effectually got rid of as at the present day. Formerly the defect was, that the tubes were burned; but where coal could be obtained at much less cost than coke, a want of simplicity, or the necessity of slight additional repairs, might be overlooked. When first brought forward, an objection was taken to Mr. Hall's plan, that when an engine was standing at a station, black smoke was emitted. This was remedied by the introduction of a small jet of steam in the chimney, for creating a draft when the engine was at rest; but the noise thus produced caused the plan to be laid aside.

In regard to the general question of smoke-prevention, it was argued that neither deflecting plates nor brick arches were needed; but only the introduction of a sufficient quantity of air, moderately diffused over the fuel. In 1856, the use of hollow stays and small jets of steam had been suggested by Mr. Robert Longridge, particularly for marine engine boilers, where there was a difficulty in getting the proper quantity of air through the tubes; but it was thought that, in a locomotive, the requisite quantity of air to consume the hydro-carbons might be introduced by the hollow stays, without resorting to steam jets.

As to the comparative heating powers of coal and coke, it was sometimes asserted that the same evaporative effect would be obtained from the coke made from a ton of coal, as from the original ton of coal itself. This view was dissented from, and it was stated that careful experiments with Garesfield coal and coke showed the evaporative power to be as 100 to 89, respectively, weight for weight. In other words, 1 lb. of coal evaporated 12·54 lbs. of water, whilst 1 lb. of coke evaporated only 11·16 lbs. of water. But, inasmuch as 100 tons of coal produced only 66 tons of coke, it was evident that while 1 lb. of coal would evaporate 12·54 lbs. of water, the same weight of coal, converted into coke, would only evaporate $11{\cdot}16 \times {\cdot}66 = 7{\cdot}44$ lbs. of water; so that the true proportion was as 100 to 58.

On the other hand, it was stated that, with Midland coal, 20 cwt. of coal produced 11½ cwt. of coke, besides other products, and 6 cwt. of coke evaporated exactly the same quantity of water as 7 cwt. of coal: consequently there was a loss in converting coal into coke, for the purpose of producing steam; but considered only in reference to weight, coke had an advantage over coal in the proportion of seven to six.

It was contended that, in order to enable a proper comparison to

be made between the amount of fuel used per mile and the gross load carried, the paper should have showed—1st. What was the greatest altitude surmounted in each case, the total length of the line, the ruling gradient and its length. 2d. What was the average speed per mile for the whole distance run. And, 3d. How many lbs. of water were evaporated by 1 lb. of coal.

It was observed that, in attempting the general introduction of anthracite coal in locomotive engines in the United States for long and heavy traffic, it was found that, although there was no smoke, it was difficult to keep up the steam, and the fire-box and fire-bars were quickly burnt out. Notwithstanding these objections to its use, anthracite was in some cases a cheaper fuel than wood. Anthracite coal was burned on the Reading Railroad at the rate of 120 lbs. per mile, in engines weighing 28 tons, and carrying a gross load of 750 tons, at from ten to twelve miles an hour, on a level. The evaporation of water was from 5½ lbs. to 6 lbs. only per pound of coal. A brief description was given of Phleger's, Dimpfel's, and Boardman's boilers, which had been made to burn bituminous as well as anthracite coal, and were used on passenger as well as goods trains. Each furnished considerable space for combustion, and air was admitted in numerous fine streams over the fire. They were all, however, heavy and complicated, and inapplicable to existing stock. Within the last three or four years, renewed attempts had been made to adapt the existing stock of engines to the use of bituminous coal. The difficulties consisted in the large quantity of coal required to be burned in a given time, under an intense draft, and in the clinkery character of the coal itself. The engines were not heavier, on the average, than in England, nor had they more heating surface; but they burned more fuel and evaporated one-fourth more water in a given time. In December, 1856, Mr. G. S. Griggs, of the Boston and Providence Railroad, introduced a fire-brick arch, below the tubes, in the fire-boxes of some of the engines of that line. With a few holes for the admission of air above the fire, this arch was found to improve the working of the fire-box, when burning coal. On the Iowa Central Railroad, the grates of the coal-burning engines were at one time covered with fire-brick, so as to leave only about two square feet of the original surface of the bars exposed; and of this area, less than one square foot was air-opening. More recently, perforated door-plates and air-distributors (the latter set up within the fire-box) had been extensively adopted.

It was stated, in reply to the observations which had been made, that in a comparative trial of the author's system and Mr. Jenkins', on a metropolitan railway, on the same passenger engine, and on the same duty, the former consumed 4 lbs. per mile, or 12 per cent., less coal than the latter; that the saving of coal by smoke-prevention in locomotives had been found to be at least 18 per cent.; that the information demanded, for the purpose of making a proper comparison, was given in the paper; that it was of no use to state altitudes simply, unless particulars of inclines and length of trip were also given.—*Proc. Inst. Civ. Eng., May* 1–8, 1860.

*On Combined Steam.** By the Hon. JOHN WETHERED, U. S.

It was stated that at the present day the great desideratum in marine engines appeared to be, to obtain increased power or economy in the consumption of fuel, without the commercial disadvantage of occupying more space by the enlargement of the boilers and machinery. This object it was believed had been attained by the application of ordinary and superheated steam mixed. The mode adopted in carrying out this system was, to attach another steam pipe to the boiler, for conveying the steam to be superheated to pipes or other contrivances placed in any convenient form near the fire, or in the uptake or chimney of the boiler, or in a separate furnace; the superheated steam being added to the ordinary steam at or before its entrance into the cylinder. In its passage through the superheating apparatus, that portion of the steam was raised by the waste heat to a temperature of 500° or 600° F. The heat thus arrested was conveyed to and utilized in the cylinder, by its action on the other portion of steam from the boiler, which was more or less saturated according to circumstances. The combined steam was used in the cylinder at from 300° to 450° F., instead of at the low temperature at which steam was generally employed. The effect of using the two kinds of steam was, that the superheated steam yielded a portion of its excess of temperature to the ordinary steam, converting the vesicular water which it always contained into steam, and expanding it several hundred-fold; whilst at the same time, the ordinary steam yielded a portion of its excess of moisture, converting the steam gas into a highly rarefied elastic vapor—in other words, into pure steam at a high temperature.

It was asserted, that repeated endeavors had been made in England, France, and America, to employ steam simply dried, or superheated, and as often abandoned. This plan certainly resulted in partial economy; but owing to the high degree of temperature necessary in this case, the lubricating materials were dried up, and then the packing and rubbing parts of the machinery were destroyed. Moreover, when all the steam was superheated the temperature of the steam in the cylinder was beyond the control of the engineer. It was this difficulty which had led to the discovery of the system of employing mixed steam, which was entirely under control; for by merely turning a valve it could be so regulated as to produce the highest mechanical effect, with the most perfect lubrication to the slides and cylinders. Another advantage was, that if any accident should happen to the superheating apparatus, the cylinders could still be supplied with plain steam alone.

A series of trials on board the R. M. S. S. *Avon* had shown that the pressure in the boiler being in all cases the same, with plain steam the result was 1070 I. H. P.; with the steam from three boilers superheated and from the fourth plain it was 1076 I. H. P.; while with the steam mixed in the proportions of 61 superheated and 69 plain, 1200 I. H. P. was produced. The Lords of the Admiralty were stated to be so well satisfied with the results of experiments continued over twenty voy-

* From the London Civ. Eng. and Arch. Jour., May, 1860.

ages, that they had determined to extend the application of the system in the Royal Navy, and H. M. S. S. *Rhadamanthus* had been ordered to be fitted with it. Mr. A. C. Hobbs (Assoc. Inst. C. E.) had applied it to a high pressure boiler and engine, and Mr. Dorman had adapted it to an engine which did not produce the required power. The combined steam was also used in all the steamers of the Collins line. Experiments on board the *Gibraltar* showed that superheated steam at a pressure on the boiler of 10 lbs. produced 222 I. H. P.; ordinary steam at 14 lbs. pressure, 307 I. H. P.; while combined steam at 15 lbs. pressure gave 376 I. H. P.

When steam was merely superheated or dried, it was converted into steam gas. It consequently partook of the nature of gas; was a bad conductor of heat, and gave out with difficulty the heat necessary to transform it into mechanical power. On the other hand, mixed steam participated in the qualities of steam proper and of superheated steam, and being a pure highly rarefied vapor, which readily parted with its heat, thus produced greater mechanical effect.

By the application of combined steam the following advantages, among others, were said to be obtained:—1. An economy of fuel of from 30 to 50 per cent. 2. A diminution of one-third in the feed-water. 3. The employment of smaller boilers to produce the same power. 4. Facility of maintaining any desired pressure, or of increasing it at will in cases of emergency. 5. A steamer would make a voyage one-third further with the same weight of coals; or one-third the space now occupied by the fuel might be used for freight. 6. Less risk of explosion. 7. Boilers would last one-third longer. 8. A better vacuum was obtained. And, 9. One-third less injection water was required.

April 3.—The entire evening was occupied by the discussion of the preceding paper "*On Combined Steam.*"

In commencing the discussion it was remarked that the indicator cards taken from H. M. S. S. *Dee*, when using simple superheated steam and when working with combined steam, the pressure being the same in both cases and the supply valves equal in area, showed that a better vacuum was obtained and that the expansive force was much greater when using combined steam. It had been ascertained that the consumption of fuel was 2·57 lbs. per I. H. P. per hour with combined steam, whilst it averaged 5·53 lbs. per I. H. P. per hour with plain steam. The result of twenty experimental voyages in that vessel gave, on the combined system 500 H. P., by superheating simply 409 H. P., and with plain steam 404 H. P.

A case was also mentioned in which combined steam had been applied to a non-expansive engine, where a reduction was effected in the consumption of fuel of from 36 cwt. to 24 cwt. per week; while about one-third less water was consumed.

It was admitted that great praise was due to the author for having recalled public attention to the advantages derivable from superheating steam. But it was doubted whether the combined system possessed any peculiar merit over simple superheated steam. If the mix-

ture were made just at the entrance to the cylinder, it was difficult to understand what difference there could be between that plan and at once heating the whole of the steam to a uniform temperature. It was questionable whether in a good expansive engine the application of a most efficient system of superheating, that completely prevented condensation, would result in a saving of more than 15 per cent. It was stated that in the early experiments in H. M. S. S. *Dee*, when superheating was tried, the steam was throttled, owing to the small size of the pipes; and that the apparent superiority of the combined system was due to the large ordinary steam pipe being in connexion with the engines in addition to the superheating pipe, and not from the fact of the steam being mixed. When a different arrangement was made, the superheating gave results quite equal to the combined system.

It was believed that with the best boilers there would be a saving of 15 per cent. by the use of superheated steam; and in one vessel, where there was an indifferent construction of boiler, there was an economy of 34 per cent. due partly to improvements in the boiler, and partly to the application of the apparatus giving more steam room. In one of the vessels belonging to the Intercolonial Royal Mail Company, to which superheating apparatus had been added, the consumption of fuel was reduced from 2986 lbs. to 1900 lbs. per hour on an average of four or five days' steaming between London and Milford Haven. Similarly, in one of the boats belonging to the General Steam Navigation Company, traveling between the Thames and Scotland, an average of twelve voyages previous to superheating showed a consumption of 126 tons of fuel per voyage. This was now reduced to 90 tons per voyage. The temperature in the uptake was formerly about 650°; now it had not been reduced more than 50°, but the temperature of the steam had been increased 100°.

It was remarked that the gain in using superheated steam did not arise from any physical law, but from the prevention of a loss by the use of dense steam. When the steam entered the cylinder, if there was but one degree of heat less in the cylinder, water must be formed. When the vacuum stroke was made, the deposited water, being relieved of the pressure due to its temperature, was rapidly vaporized and passed off as rarefied vapor, cooling the cylinder. On the steam entering to make the return stroke it brought the cylinder up to a temperature due to the pressure, and the stroke was made at that loss by the deposit of water over the whole interior surface of the cylinder and its adjuncts. When the condenser again came into action the same thing recurred, and so on continuously. A pressure indicator applied simultaneously with thermometers, showed that the loss of temperature without working expansively was 20°, with an average pressure of 6 lbs., indicating a loss of steam of between one-third and one-fourth. This injurious effect must always occur when using dense steam; whereas, in employing superheated steam there was no deposit of water, and the result was analogous to that of a permanent gas, but with the advantage of easy and complete condensation. Further, when the vacuum stroke was performed, since the cylinder was per-

fectly dry, the exhaustion of the whole steam was effected instantaneously. With dense steam, the cylinder being wet, the deposited water had to be vaporized and condensed, thus damaging the vacuum. As this action did not occur with superheated steam, some increase of useful effect was produced on that ground. The condensing appliances were also relieved by so much as was gained in the cylinder.

It was believed that the practical limit of the use of superheated steam would be in giving it such an additional amount of caloric as would permit of its remaining dry steam to the end of its required expansion. When steam was expanded a large quantity of heat became latent. In consequence, the full effect was not obtained from expanding ordinary steam, because as it expanded in the cylinder it cooled, and there was not sufficient caloric to keep up the specific heat during the stroke.

It was observed, that the experiments on H.M.S.S. *Dee* showed a saving of 23·8 per cent. in favor of superheated over plain steam. With regard to temperature, the superheated steam lost 20° on its passage to the cylinder, 82° after entering the jacket, and 26° more after entering the cylinder; while the plain steam lost 23° only, after making its entire circuit from the boiler to the cylinder. In another experiment there was an economy of fuel of 20 per cent.; the minimum consumption at full power being 2·6 lbs. of Welsh coal per H. P. per hour. It was thought that Mr. Wethered's system was about as economical as the superheated, when the whole of the steam was passed through the superheating apparatus. It was contended, that superheating should not be carried farther than to prevent condensation in the jacket, and therefore in the cylinder; and it was thought that the whole of the steam passing into the cylinder should go through the jacket, rather than that the jacket should be fed by small pipes.

It was pointed out that mixing ordinary saturated steam with superheated steam, gave a ready means of regulating the temperature. It was thought, that the increase of temperature should never exceed 100°. If a compensation-rod were introduced into the steam-pipe, so as to limit the admission of steam in proportion to the temperature, beneficial results might be obtained.

In reply to the observations which had been made, it was stated, that it had not been desired to advance any crude theory, but rather to narrate facts. The rationale of the principle advocated had however been given in the paper, nearly in the words of Prof. Regnault, of the French Academy. The difference between superheated and combined steam was stated to consist in this, that superheated steam being of a gaseous nature, was a bad conductor of heat, and parted with it with difficulty; whereas combined steam being pure vapor, and a better conductor of heat, parted with the heat more readily and left more heat in the cylinder of the engine, which was converted into mechanical power. The engineer-in-chief of the United States Navy had proved that there was an economy in the use of the combined steam of 52·5 per cent. over ordinary steam, and 25 per cent. over superheated steam. The experiments conducted under the authority

of the Minister of Marine of France, gave nearly the same results, the figures being 52·7 and 24·0 per cent. respectively.

In the British Admiralty yacht *Black Eagle*, there had been found to be a saving of 20 per cent. in favor of the combined over the simply superheated steam.

In closing the discussion it was stated that the general opinion appeared to be, that the practical introduction of the system of superheating steam was greatly owing to the exertions of Mr. Wethered. He had succeeded in moving the British Board of Admiralty when, perhaps, an English engineer might not have been so successful; but this should be a subject of congratulation, as it was desirable at all times to give the greatest encouragement to foreigners, so as always to attract the best talent from other countries. The case did not, however, seem to be clearly established in favor of combined steam; it rested upon the facts which had been stated, and not upon any scientific explanation of the rationale of the principle, such as would account for the results claimed for it. When more than ordinary attention was given to any machine in daily use, that of itself would often lead to economy. This attention was invariably given when any new invention was being tried, and the whole improvement, or economy, was supposed to arise from the particular modification then being tested.—*Proc. Inst. Civ. Eng., March 27th and April 3d*, 1860.

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*Extract from a paper "On Indian Railways; with a description of the Great Indian Peninsula Railway."** By Mr. JAS. J. BERKLEY, M. Inst. C. E.

The materials procurable in India for railway purposes were then succinctly noticed. In reference to the manufacture of Indian iron and the supply of coal, it was remarked that active and successful operations depended more upon the completion of railway communications, than the railways did upon a local supply of those materials. The properties of a few of the various kinds of woods which had been extensively used, were then stated. Those which had been successively converted into sleepers were—teak, blackwood, khair, errool, and red eyne. The cost of a sleeper varied from four shillings to seven shillings and seven pence, the average price being about six shillings. Tolerably good bricks had been occasionally procured and used in arches, but in such cases a proportion of only twenty per cent. had been selected from the best native kilns. The price ranged from ten shillings to twenty-four shillings a thousand. Gunpowder cost, when made upon the spot, about £ 34 per ton.

Native labor, by which these works had been executed, was cheap, but very inferior to that of England. Nearly one hundred thousand men had been employed upon the Great Indian Peninsula Railway lines at one time, and as many as twenty thousand on the Bhore Ghaut Incline alone. The wages of the several classes per day were now—

*From Newton's London Journal, June, 1860.

native maistries, or foremen of masonry, brickwork, or carpentry, 2*s.* 6*d.*; masons, 1*s.* 9*d.*; bricklayers, 1*s.* 3*d.*; carpenters, 1*s.* 6*d.*; smiths, 2*s.*; miners (a very large class), 9*d.*; excavators, 7½*d.*; and laborers, 6*d.*

The whole of the Great Indian Peninsula Railway had been executed by contract, and this, it was believed, had led to remarkable economy in the construction of the various lines. The average cost of the opened portions had been about £8000 per mile. The introduction of the contract system into India, on a large scale, was an important effect of railway enterprise, and it was thought that its advantage could not be long confined to railway construction.

Railway enterprise had already produced important effects in Western India. It had earned, at a remarkably low tariff, more than the guaranteed dividend. The working expenses had been low, notwithstanding the dearness of imported fuel and European superintendence. It had afforded the advantages of the best mode of conveyance to immense numbers of the poorest and lowest orders of the people. It had generated for itself new sources of traffic. It had achieved its success in competition with water carriage, and when it was only in a fragmental state. Although constructed in what was erroneously called an expensive style, the traffic had already demanded the partial laying of a second line of rails. It had raised the wages and increased the effectiveness of native labor, and profitably employed thousands of the carriers of the country. It had opened quarries and brickfields, had impelled trade into unwonted activity, and drawn largely upon the resources of the country. It had lessened the expenditure of the state, by its cheap conveyance of mails and troops, and had augmented its income, by large payments of tolls and duties. *Proc. Inst. Civ. Eng., May* 8, 1860.

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*The North Atlantic Telegraph.**

Long before the Atlantic Telegraph, which has repeatedly failed, was commenced, Col. T. P. Shäffner, an American gentleman of some repute as an electrician, called upon us, we recollect, for the purpose of pursuing certain interesting inquiries into the progress of the electric telegraph in this and other countries. From time to time we have been advised of the efforts subsequently made by this gentleman in the interests of an Anglo-American line of telegraphs, and now we have before us a full statement of the plans to which his prolonged inquiries and investigations have conducted him.

Col. Shäffner proposes to establish a North Atlantic telegraph on the following route, viz: From the North of Scotland to the Bay of Thorshaven, Stromöe Isle, of the Faröe Isles. The length of the cable for this section will be about 250 miles. The next section will run from Westermanshaven, of the same isle, to about Portland, South Iceland, a distance of about 350 miles. From this landing the line

* From the Mechanics' Magazine, May, 1860.

will be constructed across Iceland to Reijkiavik. From the Bay of Reijkiavik the next section of cable will be run to some bay on the east coast of Greenland, south of latitude 61 deg. north. This distance will be about 550 or 600 miles. It is proposed to run the line across the southern end of Greenland. The fourth section of cable will be run from one of the bays of the west coast, south of the latitude 61 deg. north, to Hamilton's Inlet, on the Labrador coast, a distance of about 600 miles. The aggregate submarine telegraph will be about 1750 miles; land lines about 300 miles, total, some 2050—about the same length as the Atlantic cable from Ireland to Newfoundland. In a paper read a few days since before the Royal Geographical Society, Col. Shäffner quoted the above figures as correct estimates, and stated that the concession for this telegraph has been granted by his Majesty the King of Denmark, so far as it may occupy Danish territory. There is no monopoly of the line reserved to the Danish government, but its impartial use is guaranteed to the whole world. The government has pledged itself to "bestow all necessary care, vigilance, and means which may be within its command, to insure the free, impartial, and unhindered use of the said telegraph line." If, however, the British government should desire a wire for the transmission of its own despatches, a franchise can be given to it, and the use of that franchise will be defended by the Danish government "with all the means within its command."

The distinguishing feature of this plan is, of course, the shortness of submarine circuits which it secures, and the consequent avoidance of those electrical difficulties which attend the use of very long circuits. The longest circuit required will be but 600 miles—which is 150 miles less than one already in successful operation. Through such a circuit the promoters say they can transmit at least twenty words per minute. "It will be a financial question that will determine the capacity of the cables for the commercial telegraphy," says Col. Shäffner. "Between Scotland and the Faröes, and between the Faröes and Iceland, cables can be laid that can equal the working of a double line of cables across the other sections of the route, or perhaps it may be found best to construct them for the short sections with two wires for telegraphing, and on the other sections with three or more conducting wires. If either one of the sections fail, the whole are not lost, and another cable can be promptly submerged."

The depths of the seas which would be traversed by the proposed cable are but little known. A few soundings were taken on the route last autumn, when Col. Shäffner made the voyage from Labrador to Greenland in a 200-ton barque, and effected a reconnaissance of that part of the route. His examinations were general, and not in sufficient detail to justify him, in his opinion, in specifying the proper localities for the landings of the cables; and it is for this purpose, and for making the most complete survey of the seas and lands, and for making scientific observations generally, that a government expedition has been requested, as stated in our last number. Besides the aid to be given by the government in the survey, we understand that a pri-

vate expedition will be sent to fix the route on the respective territories to be traversed by the telegraph. The water between Scotland and the Faröe Islands, and thence to Iceland, is not very deep—not exceeding, perhaps, 1000 fathoms, and there can be no doubt but that the bottom is very deep mud. The soundings taken last fall between Iceland and Greenland, proved the greatest depth of water was 1540 fathoms. The mud brought from the bottom has been examined by Professor Ehrenberg, of Berlin, and he says that he found it "to contain numerous shells with life-being forms therein, which (in his opinion) exist alive at the bottom of the sea." With regard to the sand contained in the specimens, he says, that "it is no rolling sand, but fragmentary, broken, and dissolved stones of mountains. The granules are not round, but with acute sides. The granite sand consists of much glimmer and quartz, with green crystal fragments, which might be hornblende were there particles of pumice-stone, but which are not at all therein to be found." It would seem that the bottom of the sea gradually descends to 1540 fathoms from Iceland, and then in the same manner ascends to the Greenland coast. To determine the correctness of this opinion further soundings are required. The Arctic current, perhaps some thirty feet deep, and by some supposed to be fifty miles wide, carries with it large quantities of ice, from which earth drops to the bottom of the sea. The sea between Greenland and Labrador was found by Col. Shäffner to be 2090 fathoms, which was about under the Arctic current, west of Greenland, latitude 61 deg. ·05 min. North-west of this sounding the deepest water found was 1840 fathoms. The bottom in Davis's Strait was soft mud, except under the Arctic current, where it was coarse sand, which had been evidently dropped from the ice. On many icebergs may be seen large quantities of sand and boulders of several inches in diameter.

The precise places for the landings of the cables have not yet been determined upon, but Col. Shäffner has brought together many useful facts for the guidance of the projectors. There are good bays on North Scotland, and there need not be any fears as to that part of the route. The bay of Thorshaven, island of Stromöe, of the Faröe group, is approached from the deep sea without obstruction, and its bottom is sand. The average depth of water in the bay is about 20 fathoms. Thorshaven is the capital of the Faröe islands, and has about 900 inhabitants. The cable to Iceland will leave Westermanshaven on the west coast of the Stromöe Isle. The bay is deep, he says, bottom sand, and free from the ocean waves. On the south coast of Iceland, about long. 19 deg. W., or at Portland, it is proposed to land the cable. The bottom of the sea approaching nearly the whole south coast of Iceland is sand. The coast is free from ice winter and summer. The cable to Greenland will run, Col. Shäffner continues, from Reijkiavik bay. The depth of water in this bay is favorable, the bottom is mud and sand. It is free from ice, winter and summer, excepting a little crust near the shore. Arctic ice is never seen in that bay, except, perhaps, once in a century. Reijkiavik is the capital of Iceland, and its inhabitants have the highest

degree of education. The landing-places on Greenland require to be selected with great care, and after much investigation. It is proposed to land on the east coast, in one of the many bays south of latitude 61 deg. north, and on the west coast near the town of Julianshaab, or south of that place, connecting the two with a line across Greenland. The bays penetrate to the interior ten, twenty, or thirty miles, and some of them never freeze, nor does the ice from the sea go up them more than a few miles. They are very deep, and bergs never ground in them; the bottoms are of mud and sand. The characters of the bays on the two coasts are much the same, and the Arctic current does not approach the coast on either side. From the sea into these bays the water is deep, far below the reach of the greatest icebergs. To make the selection of the proper bays for the landings of the cables, the fullest information as to the depth of water from the sea will be required. Some of the inlets bring out ice, but most of them do not; many of them are ten miles wide. As to Labrador, Hamilton's Inlet affords all the desired advantages. This inlet runs interior about 140 miles, and at its mouth it is thirty miles wide. The water is deep and the bottom is sand. At its mouth there is a deep trench to the sea, and a cable laid in that trench would never be disturbed by the sea. Above and below the mouth of Hamilton's Inlet there are shoals or reefs, some thirty miles from the coast, and many icebergs ground on them. After they melt or break to pieces they pass over and beyond the mouth of the inlet. They never ground at the mouth, nor do they enter into the inlet.

The above statements are made, let it be understood, on Col. Shäffner's authority. We take the following extract also from his Paper:—

The landings on the Faröe Islands and Iceland will never be disturbed by ice. They are open ports, and vessels can go and come from them at all seasons of the year. The coasts of Greenland and Labrador are beset with much ice. The east coast of Greenland is but little settled. The inhabitants trade with the colony near Cape Farewell, but they go and return from time to time in their skin-boats. The Arctic or Spitzbergen current, with the floe ice, does not approach the coast, and much of the time that the floe ice runs between Greenland and Iceland the water near the coast is free from ice. The floe ice on the east coast may be seen in more or less quantities in the months of February. March, April, May, and a part of June. Sometimes it appears in the last days of January, and occasionally disappears in May. The coast or berg ice may be seen occasionally throughout the year. On the east coast neither the berg nor the floe ice penetrates the bays, and a cable laid therein would never be disturbed by them even were the waters shallow. The hills on the coast are covered with grass and berry bushes. The climate is not severe. The native ice is not very thick, and if it was the cable could not be injured by it. The west coast in Julianshaab district is settled by some 3000 Esquimaux and Danes. Their houses are to be found on many of the hills, and the skin-boats are to be seen at nearly all times in some of the bays. The floe ice runs northward a few miles from the coast during the months that it is seen on the east coast. Between the green hills and the floe the sea is open and free from ice—except, perhaps, here and there a berg may be seen. Icebergs from Baffin's Bay, or the various "blinks" more northward, will be found scattered along the coast. Some ground on the reefs or shoals, some are blown into the bays, and others pass off to the south. Those blown into many of the bays seldom, if ever, get out. If the bays have currents from the interior they are taken out to sea, but if their waters be quiet, as many of them are, the bergs are blown to the land and ground. There they remain until the winds, the sun, and the tidal waves crumble them to pieces. Between the Arctic current and the coast many of the icebergs remain for weeks, and, in fact, until broken to pieces and

melted. The largest iceberg may be some eighty feet above water, but as to their depth in the water, no one knows, nor is it possible to ascertain. The theory as to the specific gravity of ice cannot be applied to determine the depth of any given berg. The ice above water may be the cone ascending from a very broad base. In most cases very high bergs are very wide below water, and when the base becomes reduced, the berg falls, and a new projection is seen from the water. The crumbling of bergs, and the changing of their positions, are to be seen going on at nearly all times. A rough sea soon exposes the form and size of the berg, and a careful judgment can determine the probable bulk. The bergs on the Labrador coast are of the same kind as those on the Greenland coast. They go south in great quantities until checked by the eddy currents on the east coast of Newfoundland. Many of them enter the bays of Newfoundland, and a cable laid therein will be more liable to be injured by the ice than those laid on the Greenland or Labrador coasts.

We think Col. Shäffner is likely to meet with all needful encouragement in this attempt of his. The commercial world wants a telegraph to America, and, notwithstanding former failures, are prepared to find funds for a new attempt, if it has any real promise in it. Regions of thick-ribbed ice do not seem very promising places for telegraphs and telegraphic operations; but late events have familiarized us with those regions, and there is good reason for believing that the mechanical difficulties which will interfere with the new Atlantic Telegraph will be more easily surmountable than the electrical difficulties of the more southern route. In the absence of a mid-Atlantic island or two, it may be wise to run away northward for a bit of land to plant a station upon.

Meantime we must not forget that the old Atlantic Telegraph Company have sent out an expedition for the purpose of restoring their cable, which has only failed, they say, because a fault in the insulation, which existed before its immersion, was allowed to escape notice. They contend that there is reason to believe the insulation remains perfect in the deep-water portion, and that experience affords grounds for anticipating the recovery of the injured portions. Mr. Saward, the Secretary to the Atlantic Company, in a letter just received, compares the two rival routes, showing that the extreme length of the existing Atlantic line of Telegraph (from London) is but 2650 miles, whilst that of the Danish route will, he says, be 3773 miles. To work this line of nearly 4000 miles at a remunerative speed would, he adds, require relays at each broken point—in all not less than 14 sets of relays to be worked in synchronous connexion, each with each. These continuous sections, owing in a great degree to their circuitous course and their constant change of position in reference to the magnetism of the earth—the first links being south to north, then east to west, and lastly, north to south—would, he argues, more than in any other quarter of the earth, and in a greater ratio than any direct line, be subject to the adverse influences of earth currents, magnetic storms, aurora borealis, the chance of accidents, and other disturbing causes, always more incident to long and frequently-broken circuits, and any one of which would destroy for days the synchronous working of the relay system, and reduce the operation at best to one of slow and tedious repetition from station to station. "I would further remark," he says—and he is quite right in saying so—"that any survey of

the Greenland coast, with the view to ascertain its capabilities as a cable station, would not be at all conclusive or satisfactory if it does not embrace, at the very least, eight or nine months' resident examination of the coast, both on its eastern and western sides; as the practicability of that route for telegraphic purposes must depend, not merely upon the bare possibility of laying a cable there during one particular month in a Greenland summer, but upon the probability of its remaining intact during the stormy seasons, and the facilities for rapidly repairing it when broken."

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*On the Wave-line Theory.** By JOHN SCOTT RUSSELL, Esq., F.R.S. Being an abstract from his Paper read before the Institution of Naval Architects, March 3, 1860.

After briefly recapitulating the chief portions of the Paper which he read at the Inaugural Meeting, two days before, the Author said his object in his present Paper was to consider the nature of the motion imparted to water when disturbed by a vessel pushed through it by motive power of any kind. It was in the investigation of this subject that he had seen some of the most important principles that guide us as to the general proportions of ships, as well as their shape, with reference especially to velocity.

The first inquiries to be made were,—what became of all the water which a ship removed out of her way? and how did it get out of the way? In prosecuting these inquiries the Author had first employed a small trough or canal, a foot wide, a foot deep, and of considerable length, and began with a very simple experiment. He supported a small heap of water above the level of that in the trough by means of a partition at one end, and then withdrew the partition to see what the water would do, and found that it assumed a beautiful wave-form of its own, ran along the whole length of the channel to the end, and left the surface of the water over which it passed as still as it was before. Had the end of the trough been just level with the surface of the still water, the wave would have jumped over and left the whole of the water in the canal perfectly undisturbed. This phenomenon is now known as the "solitary wave of translation." This wave would travel to an almost incredible distance. The Author had followed such a wave on horseback, and by other means, for miles. It leaves a little of itself, however, along the whole surface over which it passes.

The next fact ascertained was that, whenever the bow of a ship is moved through the water a wave of this kind is produced, and this is the "traveling" or "carrier wave," which gets rid of all the water out of the canal which the vessel has to excavate. The ship feels no more of it, for it spreads itself in a thin film all along the surface of the water ahead of the vessel—not behind the vessel, nor on each side of it—with a far greater velocity than that of the vessel itself. After having made experiments on a small scale, the Author took vessels on

* From the Lond. Mechanics' Mag., April, 1860.

a large scale, had them dragged by horses, and in other ways, through the water, and by positive observations and measurement found that this was really what became of the water displaced by the bow of a boat. On one occasion he drew so large a number of boats along a canal in one direction, on a certain day, that the waves carried a great part of the water from one end of the canal to the other, and in the evening the water in the canal was found raised 18 inches at one end, and depressed to the same extent at the other. The velocity with which the traveling wave moved was found to depend entirely on the depth of the water.

At	3	feet deep	the wave travels	6	miles an hour.
"	5	"	"	8	"
"	7	"	"	10	"
"	10	"	"	12	"
"	15	"	"	15	"
"	20	"	"	18	"
"	30	"	"	20	"
"	40	"	"	25	"
"	50	"	"	30	"

In addition to a constant velocity this wave has a constant shape, a drawing of which was exhibited by the Author. And a most extraordinary circumstance was that its form corresponded exactly with the form of bow which he had previously, and from altogether different considerations, constructed as the form of least resistance. Moreover, he found that what he had endeavored to do in constructing that form, viz : move the particles of water gradually out of the way from one position of rest to another, the traveling wave also did; for on closely observing the water in the experimental trough under the action of such a wave, he observed that it lifted every particle of water over which it passed out of one place forward into another place, and there left it perfectly at rest. In the traveling wave, therefore, as in ordinary waves, the particles of water composing it were continually being replaced by others, while the wave itself advanced without apparent change. The foregoing facts convinced the Author that the form of bow which he had adopted, and which has since been called the "wave form," was analogous and conformable to the nature of water and of wave motion.

Like many others, the Author at first thought that the stern of a vessel ought to be of the same form as the bow; but thought it proper to undertake a series of experiments with the view of ascertaining what happened when a hole in the water had to be filled up. Where did the water that filled it come from? And how did it come? He first found that the hollow made in the water had no tendency to travel with an independent velocity of its own, but moved just as fast, and only as fast, as the body which produced it. He then discovered that the currents of water rushing into such a hollow, from different directions, met and produced a wave, which he called the "following wave," or the "refilling" or "replacing wave," and which always moved with the velocity of the ship, and had nothing to do with the depth of the water. The "following wave" also repeated itself in

an endless series astern of the vessel. The Author explained that the nature of this wave required that the stern of the ship should be formed of cycloidal curves, and showed how this fact was applied in actual construction.

The Author might be asked (reverting to the wave at the bow)—what became of the water at the bow supposing he dragged the boat faster than the water could spread itself? The answer was—With only a moderate force at his disposal the boat could not be made to travel faster; but if he had force enough to compel it to go in spite of the water, the water would rise up and stand on both sides of the boat until the load had passed, and then fall down into the hole left behind it. In a shallow canal in Scotland, where the carrier wave traveled only seven miles an hour, he had compelled a boat to go ten miles, and he found that the water not only rose up, but lifted the boat with it, so that she drew less water than before, and actually went easier at ten miles an hour than at five. Had not railways come into fashion just at the time, the country would have been covered with little troughs, and people would have been riding on the tops of these waves in an easier and cheaper mode than by any other means then known.

After explaining the different results which are sometimes obtained at trials in the Thames, owing to the velocities of the traveling wave varying with the depths of the water, the Author described the best means of observing the wave on rivers and other like places, and then proceeded to the application of some of the principles before laid down to practice. First, he said it was a delightful circumstance that the wave principle did not meddle at all with the form of a ship's midship section, but left the conductor entirely free to adopt any form of section he pleased. Next, it did not tie him down to any proportion of depth to breadth. It was, therefore, a plastic thing, and could be applied to any general form of ship whatever. The third and most important proposition was, that the wave-line prescribed the exact length of ship for every speed at which you wished a ship to go, and explains why a long ship is indispensable to speed. To go six miles an hour, your vessel must be at least 30 feet long; for eight miles an hour, 50 feet long; for 10 miles, 70 feet; for 12 miles, 100 feet; for 15, 150; for 18, 200; for 20, 300; for 25, 400; and for 30, 500. The Author had himself tried to obtain higher velocities than these with shorter vessels; and he had got them, but at such a fearful waste of power that it was insanity and folly not to lengthen the vessels for the purpose. The wave-line theory also told you that the length of the bow should be to that of the run as 3 to 2. The cause of this was explained.

The lines of the Great Eastern, the Author said, were neither more nor less than an exact copy of the wave-lines. The length of the bow was 330 feet; the length of the run 226 feet; and having got this length of entrance and run, and feeling that more capacity was wanted, it was of no use lengthening the bow or the run, because there was already provision for greater speed than the 15 miles an hour which

the power to be put into her could be expected to give; 120 feet of parallel body were therefore put into her amidships. The great ship might be of less fine-lines and still go with the same velocity.

There was a very valuable conclusion for practical ship-builders to be drawn, independently of what had been stated about the lines. It was this: that proportionate length and breadth were not necessary at all for a fast vessel. It was not necessary for a fast vessel that she should be a narrow, thin, long vessel in proportion to her size. The Author had taken vessels on the wave-line principle 200 feet long, and had made them of every variety of breadth, and as long as they were 200 feet long and had the lines belonging to 15 or 16 miles an hour, so long they had gone at that velocity with a given power. Further, the resistance which a vessel experiences from the sticking of water to the skin was a most formidable element of her whole resistance; and greater velocity in proportion to power would be got out of a vessel which was shorter than another, and also broader and deeper than another, providing length enough for the velocity aimed at were got at starting.

The Author's paper next contained remarks upon the effects of the wave-line upon the stability of ships—its bearing upon the load-water line—how it affected the form of the deck—how it should affect the structure of the vessel—how vessels should be built upon it so as to have a maximum of capacity—how the various proportions of length, breadth, and depth affected resistance—how the whole form could be so managed as to properly arrange the balance of the ship—how the wave-line affected the navigable qualities of a ship—how it affected the materials of which the ship should be built—and how it influenced the properties of sailing ships, paddle-steamers, and screw-steamers, respectively. But these considerations could not then be gone into. They would, however, appear in the Institution's forthcoming *Transactions*.

It was the duty of the Author, however, to say a word or two on the history of the subject, and the degree of novelty or non-novelty to which it pretended. And he begun with saying that he did not claim to be the inventor of hollow bows. They had existed as far back as he could trace steam navigation. When he had first discovered what he believed to be the principles of nature which bore on this subject, he felt that the form of vessel which accorded with them could not be new, and he set about examining all classes of vessels. He found proofs immediately; so many that he felt astonished that the books and treatises on naval architecture had not all told them to do nothing but make hollow bows from the beginning. He showed that it must have been impossible for barbarous men to have made a rough boat from two flat planks without forming such a bow. But the old tonnage laws had compelled builders to make ships of the greatest possible capacity compatible with certain measurements. Hence the bluff bow was made a matter of necessity. When, during the wars, we captured Spanish ships or privateers with fine and often hollow lines below—vessels which sailed admirably under their origi-

nal trim, in which they were down by the stern, we invariably found that they proved but dull sailers in our hands, owing undoubtedly to the fact that we not only overloaded them with weights, but trimmed them nearer to an even keel, and so brought the bluff upper part of their bows down into the water. The boats of the London watermen illustrated the same principle. The Author next alluded to the *Vesper*, built from Mr. Ditohburn's design by Fletcher and Fearnall, in which, on coming to London in 1836 or 7, he found a confirmation of the views which he had embodied in the *Wave* in 1835. He also referred to a boat built by the late Mr. Assheton Smith, and to several other vessels built successively by himself and others.

The Author concluded by stating that the rapid advancement of confidence in the wave principle was owing very much to the British Association for the Advancement of Science, which had placed at his disposal large means for the prosecution of scientific researches into this subject, and had every year enabled him to publish to the world the progress which he was making in the investigation.

*State of Railways in Spain.**

At the close of the year 1859, the following was the state of railways in Spain, with their annual receipts:—

	Kilometres in length.	Receipts 1859. Reals vellon.
Madrid to Alicante,	482	44,228,893
Madrid to Saragossa,	57	2,126,720
Cordova and Seville,	131	4,259,146
Valencia and Almansa,	138	6,430,425
Alar and Santander,	91	8,540,372
Barcelona to Saragossa,	37	2,905,680
Barcelona to Martorell,	27	2,083,765
Barcelona to Arenys,	36	4,185,787
Barcelona to Granollers,	29½	2,742,050
Jerez to Trocaders,	27½	3,717,408
Langres and Gijon,	39	
Tarragon,	14	761,198
Totals,	1109	81,981,444

The Langres and Gijon line, in 1858, received 1,832,071 reals vellon (1*l.*=96 reals vellon).

On the Decay and Preservaton of Building Materials.† By Prof. Ansted.

Prof. Ansted commenced by directing attention to the state of the stone in many of the principal buildings in England and on the Continent, illustrating the extreme irregularity with which various materials, and even various samples of the same material, resist the action of the weather and fall into decay. He then described the chief building

*From the London Builder, No. 893. † From the Lond. Athenæum, May, 1860.

materials, explaining in each case the cause of decay. Commencing with a general remark, that all stones are rotten and weathered at the top of a quarry or near an earthy surface, and that the action of the weather on them is in some measure thus indicated, he first alluded to granite. He stated its properties of hardness and great durability in ordinary cases; but remarked that when soda replaced potash in the felspar, the crystals of felspar were subject to the action of the weather, and that, from some cause little known, the silica base also occasionally failed. Still, the great practical objection to the use of granite is its cost. Passing next to the sandstones, he defined them, mentioning the chief varieties. He stated that the nature of decay in sandstones was generally the failure of the cementing medium, which is sometimes silicious, but more frequently calcareous, or clayey, or even oxide of iron. He pointed out as the causes of decay, the want of sufficient cohesion in the cementing medium—the nature of the cementing medium itself, and the effect of expansion and contraction of water absorbed by the stone. The limestones were next considered, and the principal varieties passed briefly under review. They are all freestones—some are crystalline, others semi-crystalline, but most of them are earthy, or oolited and absorbent. They consist of particles of carbonate of lime, whether grains, as in the case of chalk, or accumulated lumps like oolite or roe-stone, or fragments of shell; and these particles are cemented together by carbonate of lime. The stones are generally laminated, though the bedding is often extremely obscure. When exposed to the action of the air in towns, they absorb moisture and acid gases very readily, and the result is a gradual destruction of the surface, and often a rapid removal of the particles beneath the surface, especially on the planes of bedding. When stones are not placed in a building as they were in the quarry, the surface peels off in natural films, and is more rapidly acted on than it need be; but not unfrequently, even when well placed, the surface gets hardened by exposure more rapidly than the substance of the stone, and a scaling still takes place. The more exposed parts, those subject to drip and constant damp, and the more delicately sculptured portions, are among the first to decay; and, owing probably to differences in the mode or rate of deposit of the mud of which the limestone was formed, or some partial change that has since taken place, there is great irregularity in the rate of decay. Magnesian limestones, or dolomites, when quite crystalline, behave like marble; but when, as is usual, only half crystalline, they are very apt to become reduced to powder in parts, and the decay thence proceeds with extreme rapidity. The Professor next proceeded to consider the remedies for decay. He alluded to paint as at once unsightly and not permanently beneficial, and included the large class of preservatives that have been suggested, in which any animal or vegetable oil or fatty matter was contained, as equally valueless, either peeling off or rotting in the stone, and leaving it soon exposed to ordinary decay. The mineral bitumens, he stated, had not been much tried, owing to their dark, unsightly color. What is required is some mineral preparation. He then alluded to the water-

glass, a soluble silicate of potash, originally described by Dr. Fuchs, and applied to indurate stone by M. Kuhlmann. He explained the principle of this process as depending on slow decomposition by exposure to the air, and stated, that, as meanwhile the influences of the weather continued to act, the method could not be adopted with advantage in the open air in a damp climate, where preservation is chiefly required. The only plan that, as far as he was aware, met the requirements of the case, he stated to be that adopted by Mr. Ransome, according to which the absorbent surface, whether of stone or terracotta, was saturated with the diluted solution of soluble silicate of soda, and then treated with a solution of chloride of calcium. By the mutual action of these solutions, a double decomposition is induced, the silicic acid parting with its soda to the chlorine, producing chloride of sodium, or common salt, and combining with the lime to form silicate of lime. The salt being washed away, only the silicate of lime remains. The silicate of lime thus thrown down he next explained to be a salt, which was not only itself non-absorbent and singularly powerful in resisting the action of ordinary atmospheric influences, but as having the property of adhering rapidly to the surface of the minute particles of which stone was formed. He illustrated this by the case of mortar and concrete, which owe their adhesive properties to this habit of silicate of lime, which is the mineral formed by the mutual action of the cement on the substances in contact with it. The stone having its particles thus coated with silicate of lime, and all the absorbent surface being thus protected, the result is an immediate and great hardening of the stone, so far within its substance as the solutions have been absorbed, and a complete immunity to that extent from the action of atmospheric influences. The stone does not necessarily become non-absorbent, though it can be made so; but it absorbs much less rapidly than before, and appears to resist decay much in the way that some of the best natural sandstones, such as Craighill, are known to do.

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*Do Railway Rails ever wear out?**

At the late meeting of the West Flanders railway, Mr. Herapath having mentioned on the experience of one of our ablest practical railway men, that the rails, unless at the stations and places where there is skidding, do not sensibly wear out, was afterwards spoken to upon the subject by a gentleman, and a railway chairman, who seemed to misunderstand what Mr. Herapath said, and adduced the splitting and exfoliation of some of the rails in disproof of what they called a theory. Lest others should run away with the same mistaken notions and misapprehensions, we think it necessary to say that the non-wearing out applies to rails made with good iron, not inferior iron tinned over, as it were, with good, of which far too many rails are made, and to rails on the middle of a line over which the trains run in the ordinary way. Experiments have been made, by taking up and carefully weighing

*From Herapath's Railway Journal, No. 1091.

rails in this position after 12 months wear, or more, which were found not sensibly to have lost any weight during that time, thereby proving that there could have been no sensible wear. Besides, we have been assured that after being down for many years, they showed no signs of material wear, which justified the statement which Mr. Herapath made, on the authority given him. It is true that near stations and places of shunting where there is much sliding and slipping by the application of the brakes, or otherwise, there is very sensible wear. But this is caused by slipping friction, not rolling, which is incomparably less than the former, though it seems we have ex-railway chairmen quite innocent of the knowledge of that simple fact.

MECHANICS, PHYSICS, AND CHEMISTRY.

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*New Secondary Pile of great power.** By M. G. Planté.

Jacobi proposed recently the use of secondary electric currents for telegraphic purposes, and Planté had suggested the substitution of electrodes of lead for those of platinum in these batteries. A more extended study has convinced him of their use. He states that a battery with electrodes of lead has 2½ times the electromotive force of one with electrodes of platinized platinum, and six times as great as that of one with ordinary platinum. This great power arises from the powerful affinity which peroxide of lead has for hydrogen, a fact first noticed by De la Rive. The secondary battery which he recommends has the following construction. It consists of nine elements, presenting a total surface of ten square metres. Each element is formed of two large lead plates, rolled into a spiral and separated by coarse cloth, and immersed in water acidulated with one-tenth sulphuric acid. The kind of current used to excite this battery depends on the manner in which the secondary couples are arranged. If they are arranged so as to give three elements of triple surface, five small Bunsen's cells, the zincs of which are immersed to a depth of seven centimetres, are sufficient to give, after a few minutes action, a spark of extraordinary intensity when the current is closed. The apparatus plays, in fact, just the part of a condenser; for by its means the work performed by the battery, after the lapse of a certain time, may be collected in an instant. An idea of the intensity of the charge will be obtained by remembering that to produce a similar effect it would be necessary to arrange 300 Bunsen's elements of the ordinary size (13 centimetres in height), so as to form four or five elements of 3½ square metres of surface, or three elements of still greater surface. If the secondary battery be arranged for intensity, the principal battery should be formed of a number of elements sufficient to overcome the inverse electro-motive force developed. For nine secondary elements about fifteen Bunsen's cells should be taken, which might, however, be very small.

From the malleability of the metal of which it is formed, this battery

* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

is readily constructed; by taking the plates of lead sufficiently thin, a large surface may be placed in a small space. The nine elements used by Planté are placed in a box 36 centimetres square, filled with liquid once for all, and placed in closed jars; they may also be kept charged in a physical cabinet, and ready to be used whenever it is desired to procure, by means of a weak battery, powerful discharges of dynamic electricity.—*Comptes Rendus, March 26th*, 1860.

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*Description of a Patent Blast Gas Furnace.** By J. J. Griffin, F.C.S.

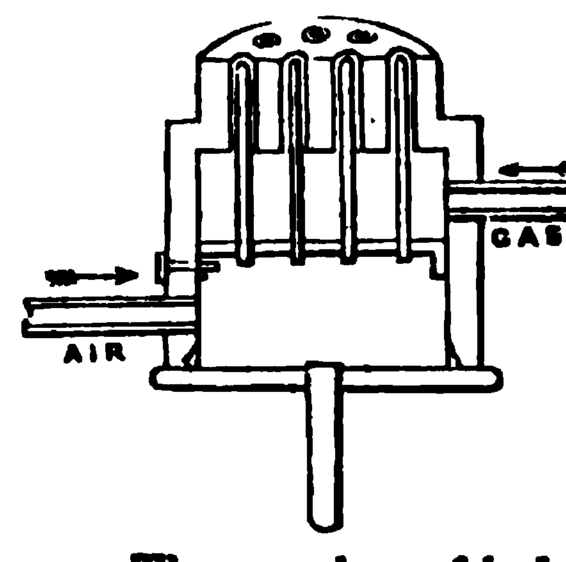
The patent blast gas furnace consists of two parts, namely, of a particular form of gas burner, which is supplied with gas at the usual pressure, and with a blast of common air, supplied by bellows or a blowing machine, at about ten times the pressure at which the gas is supplied.

Secondly, of a furnace which is built up in a particular manner, round the flame that is produced by the gas-burner, and the crucible that is exposed to ignition. The object of the particular construction of this furnace is to accumulate and concentrate in a focus the heat produced by the gas flame, and to make it expend its entire power upon any object placed in that focus.

This apparatus can be made of various sizes, according to the amount of work which is required from it. We describe below a few varieties of the furnace, and the results of some experiments made with them, which will show the reader what kind of work it is able to execute.

The Gas-burner.—The gas-burner is a cylindrical iron reservoir, containing two chambers, which are not in communication with one another. Into the upper chamber, gas is allowed to pass; and into the lower chamber, air is forced by means of tubes. The upper part of the burner is an inch thick in the metal. Through this solid roof, holes are bored for the escape of the gas. The experiments described hereafter were made with a burner that contained sixteen holes; but burners with six holes, and with twenty-six holes, have been made for other purposes. The number of holes depends, of course, upon the heating power required from the burners. The air passes from the lower chamber, through a series of metal tubes, placed in the centre of the gas-holes, and continued to the surface of the burner, so that the gas and air do not mix until both have left the gas-burner, and then a current of air is blown through the middle of each jet of gas. The bottom of the gas-burner is made to unscrew, and the division between the two chambers, which carries the air-tubes, is easily removable, for the purpose of being cleaned. The gas and

Fig. 1.



*From the London Chemical News, No. 3.

air pipes are both half an inch in the bore, and are ten inches long; the gas has usually had a pressure of half an inch of water, and the blast of air about ten times that pressure. The quantity of gas used in an hour was about 100 cubic feet. The stop-cock which supplied it had a bore of half an inch.

When the gas is lighted and the blast of air is put on, the flame produced by the gas-burner is quite blue and free from smoke. It is two inches in diameter, and three inches high, and the point of greatest heat is about two inches above the flat face of the gas-burner. Above this steady blue flame there rises a flickering ragged flame several inches in height, varying with the pressure of the gas. In the blue flame thin platinum wires fuse readily.

When the gas is burning in this manner, and the apparatus is attached to flexible tubes, the burner may be inverted or held sideways, without disturbing the force or regularity of the flame, so that the flame may be directed into a furnace at the bottom, the top, or the side, as circumstances may require.

The following articles are used in building up a gas furnace for different experiments. They vary in size according to the volume of the crucible, or the weight of the metal which is to be heated.

1. A circular plate of fire-clay, two inches thick, with a hole in the centre, which exactly fits the upper part of the gas-burner, which is made to enter into the hole three-quarters of an inch. In external diameter, this clay plate agrees with each size of furnace.

2. A cylinder of fire-clay, of which two pieces are required to constitute the body of each furnace. In the middle of each cylinder, a trial hole is made, one inch in diameter, to which a fire-clay stopper is adapted.

3. A fire-clay cylinder, closed at one end and pierced near the open end with six holes, of half an inch in diameter. The thickness of the clay is immaterial.

This cylinder is three inches high and three inches in diameter.

4. A circular plate of fire-clay, two and a half inches or three inches in diameter, and one inch thick. Similar pieces half an inch thick are useful.

5. A cylinder of plumbago, to be used as a crucible support. It is three inches inside diameter and one inch in height. It is pierced with twelve holes of three-eighths of an inch bore.

6. A similar cylinder of plumbago, two inches high, pierced with twenty-four holes of three-eighths of an inch bore.

7. A thin plate of plumbago, three inches in diameter, namely, of the same diameter as the above three cylinders. It has a small hole in the middle, and being of soft material, the hole can be easily cut or filed to suit crucibles of any desired size.

To suit the larger kinds of crucibles and furnaces, cylinders are made resembling the above in form, but of greater diameter.

As in all cases the heating power of the gas furnace spreads laterally and does not rise vertically, the most advisable form of the crucibles required for use in it is *short and broad*, not tall and narrow, and the

supporting cylinders must be shaped accordingly. No fire-bars or grates can be used to support crucibles in this gas furnace, because no material formed into narrow bars can sufficiently withstand its powers of fusion and combustion.

8. A plumbago cylinder, or crucible-jacket, two and a half inches high, two and a half inches in diameter, and a quarter of an inch thick in the walls. It has six holes of three-eighths of an inch diameter near one end.

9. A circular cover or dome, flanched at the bottom, and having a knob or handle at the top. It is pierced with twenty-four holes of a quarter of an inch in diameter, arranged in two rows near the bottom. This dome, when of small size, is made of plumbago. When of large size, of fire-clay.

10. Plumbago crucibles made with a solid overhanging rim, the use of which is to suspend the crucibles over the gas-burner, by means of the cylinders Nos. 5 and 6. When the crucibles are too small to fit the cylinders, the flat plate (No. 7) is filed to fit the crucible, and is then placed on the cylinder, to whose diameter it is adapted.

Besides these pieces of fire-clay and plumbago, it is necessary to be provided with a strong iron tripod to sustain the furnace; an iron pan in which to place the furnace; and a quantity of gravel, or rounded flints, not less than half an inch, nor more than one inch in diameter. These pebbles form an essential part of this gas furnace.

Fig. 2.

Gas Furnace, heated at the top, exhibited in section by Fig. 2.—*a* is the gas-burner (Fig. 1); *b* is the support for it when used below the furnace; *c* is the iron tripod support for the furnace; *d d* are two perforated clay plates (No. 1) adapted to the gas-burner *a*; *e e* are two clay cylinders like No. 2. These pieces, *a* to *e*, are similar in all the furnaces and will not require description in each example.

The interior of the furnace, as represented by Fig. 2, is built up as follows:—The clay plate *d*, is put upon the tripod *c*. Over the central hole in *d*, the clay cylinder (No. 3) is placed, and upon that cylinder two or three of the clay plates (No. 4). Upon these a porcelain or platinum crucible is placed. If it is of platinum, a piece of platinum foil may be put between the crucible and the uppermost clay plate to protect the crucible from contact with particles of iron, or against fusion with the clay. The crucible is to be covered by the plumbago jacket, No. 8. The space between this pile in the centre of the furnace and the two cylinders *ee*, which form the walls of the furnace, is to be filled with flint stones, or

gravel, washed clean and dried. The stones which answer best are rounded, water-worn pebbles of half an inch to one inch diameter. These may be piled up to the top edge of the jacket (No. 8). The number of clay plates (No. 4) must be such as to bring the top of the crucible to the distance of two inches, or two and a half inches at the utmost, from the flat face of the gas-burner *a*. In some cases, merely one of the furnace cylinders *e* is necessary, in which case the crucible and its jacket is placed directly upon the cylinder (No. 3), and when only a moderate heat is required, even the packing with pebbles may be dispensed with. Another means of diminishing the heat is that of increasing the distance between the gas-burner and the crucible.

The apparatus being thus arranged, the gas is to be turned on, and to be lighted, the blowing machine is to be put into action, and the nozzle of the gas-burner is to be depressed into the central hole of the clay plate *d*. The whole force of the blue flame then strikes the crucible; part of it forces its way through the holes in the jacket (No. 8), and part of it rises and passes over the upper edge of the jacket; after which it forces its way downwards between the pebbles. The carbonic acid gas and the vapor of water which result from the combustion of the gas, together with the nitrogen of the air, and any uncombined oxygen, accompany it. No space being left open for the escape of these gases at the upper end of the furnace, they go downwards through the interstices among the pebbles, and passing through the holes in the cylinder (No. 3), and through the central hole in the lower plate *d*, they escape finally into the air. In this progress the hot gases give up nearly all their heat to the flint stones. Water and gases escape below at a very moderate temperature, water even runs down in the liquid state, while the stones rapidly acquire a white heat, and if the blast and the supply of gas is continued, they retain that white heat for any desired length of time—for hours.

At the end of ten minutes after lighting the gas, the crucible, placed in the desired circumstances, and exposed to the full action of the heat of the gas, and surrounded by substances which are bad conductors of heat, is raised, with the jacket and pebbles around it, to a white heat. The consequence is, that the full power of the gas-jet is then exerted upon the crucible and its contents, and those effects are produced which will be described presently.

If it is desired to inspect the substances subjected to the action of heat in this furnace, the gas-burner is lifted out, and the crucible is examined through the hole in the clay plate. To make it possible to inspect substances at a white heat, the view is taken through a piece of dark cobalt blue glass. If the substances submitted to heat suffer no harm from the action of oxygen, it is better to dispense with a crucible cover, and to direct the jet of flame directly down upon the substance to be heated. The action is then more rapid. When the burner is taken out, the substance in the crucible can be stirred, if it is considered necessary.

The following experiment will give an idea of the power of a furnace of this description. A common clay crucible, three inches high and

three inches diameter at the mouth, was filled with about 24 ounces of cast iron. It was mounted as in Fig. 2, in a furnace of four inches internal diameter, and eight inches deep. The pebbles were filled in to the edge of the crucible. No crucible cover and no jacket were used. The flame was thrown directly upon the iron. In a short time the iron melted, the oxygen then converted some of the cast iron into magnetic oxide of iron, which formed a thin, infusible mass on the surface of the cast iron. At twenty minutes from the lighting of the gas, the furnace was dismounted. The crucible was taken out. A hole was broken by an iron rod in the infusible surface of oxidized iron, and the fused cast iron below it was decanted into a mould, and made a clear casting weighing twenty ounces.

In the same small furnace 32 ounces of copper can be fused in 15 minutes. When the furnace is hot, that quantity of copper or cast iron can be fused in 10 minutes.

In a furnace of the same dimensions, but with a gas-burner having only six, instead of sixteen jets, 16 ounces of copper or of cast iron can be completely fused in ten minutes if the furnace is cold, and in seven minutes if the furnace is hot.

These experiments show that within twenty minutes a heat is producible in this little furnace which is more than sufficient for the decomposition of silicates by fusion with the carbonates of potash, soda, or barytes.

(To be Continued.)

Serrin's Automatic Regulator for Electric Lamps.

The two tubes which carry the carbons are placed vertically, the one over the other; and communicate, the upper with the positive pole of the battery, the lower, by means of a train of wheels and the oscillating apparatus, with the negative pole. When the positive carbon descends by its own weight, it lifts the negative carbon through one-half of the distance, so that, as the negative carbon wastes only one-half as fast as the positive, the light is kept in the same place. The oscillating apparatus is a jointed rectangle, two of whose sides are vertical, the others horizontal; one of the vertical sides is fixed, and the other is movable and very delicately suspended so that it may either descend by its own weight or rise by the power of a spring which presses it upward. The apparatus carries at its lower part a soft iron armature corresponding with an electro-magnet operated on by the current of the battery.

When the current is not passing, the carbons are in contact; but as soon as the current is closed, the magnet becomes active, the armature is drawn down, the oscillator sinks carrying with it the negative carbon, which thus separates from the positive carbon which remains in its place, then the light appears between the points. As the carbons are consumed, their distance apart increases, the current is enfeebled, the magnet is weaker, the armature less attracted, and the oscillator rises; in rising, it disengages the train and the carbons approach each

other. As the apparatus is very sensitive, these are rather tendencies to movement or change, than actual changes. If an accident should happen, if one or both of the carbons should break, the current is suddenly interrupted, the magnet ceases to act, the oscillator rises, and allows the train to start and replace the carbons in their proper positions. The play of this apparatus is so steady and easy that it will work with the alternating currents from the electro-magnetic machine. The lamp is lighted or extinguished the moment the current is established or interrupted. The lamp, therefore, becomes very suitable for telegraphic signals or for light-houses, in which, by these means, the flashes may be obtained without any mechanism for rotation.—*Academy of Sciences of Paris.—Cosmos.*

Mode of Etching on Glass.

A painter at *Bourg-en-Bresse* in France, reports to the *Cosmos* the following singular and valuable experiment: He traced upon a piece of glass a design in white-lead mixed with linseed-oil, and when it had dried, he laid it for a few minutes over a vessel in which hydro-fluoric was generating. When the glass was removed, it was found that the parts of the glass covered by the white paint were etched, while those uncovered had not been attacked. Should this observation be confirmed, it would seem to open a new field to glass-etchers.

*Loss of Light by Glass Shades.** By WILLIAM KING.

SIR:—Having recently tried some experiments, for the purpose of ascertaining the amount of light lost by the use of various descriptions of glass shades, I thought that the results obtained might not prove uninteresting to some of your readers, more especially as it is a subject of practical importance, and does not seem to have attracted the notice which it deserves.

The following table exhibits the amount of light lost by the use of the various shades therein enumerated:—

Description of shade.	Loss of light.
Clear glass,	10·57 per cent.
Ground glass (entire surface ground),	29·48 "
Smooth opal,	52·83 "
Ground opal,	55 85 "
Ground opal, ornamented with painted figures, the figures intervening between the burner and the photometer screen,	73·98 "

As the large amount of light lost by the use of a clear glass shade excited some surprise, a sheet of common window glass was placed between the burner and the photometer screen, when it was found that 9·34 per cent. of the light was intercepted, thus confirming the result obtained by the employment of a shade of clear glass.

I may state that the shades were selected from a large number, and great pains were taken to obtain an average specimen of each kind.

Liverpool, Feb. 24, 1860.

*From the Lond. Jour. of Gas Lighting, &c., No. 192.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.**
By M. Faraday, D. C. L., F. R. S.,

Lecture II. (Jan. 3, 1860.)—*Gravitation.—Cohesion.*

Do me the favor to pay me as much attention as you did at our last meeting, and I shall not repent of that which I have proposed to undertake. It will be impossible for us to consider the Laws of Nature, and what they effect, unless we now and then give our sole attention, so as to obtain a clear idea upon the subject. Give me now that attention, and then I trust we shall not part without your knowing something about those Laws, and the manner in which they act. You recollect, upon the last occasion, I explained that all bodies attracted each other, and that this power we called *gravitation.* I told you that when we brought these two bodies [two equal sized ivory balls suspended by threads] near together they attracted each other, and that we might suppose that the whole power of this attraction was exerted between their respective centres of gravity; and, furthermore, you learned from me that if, instead of a small ball, I took a larger one, like *that* [changing one of the balls for a much larger one], there was much more of this attraction exerted; or, if I made this ball larger and larger, until, if it were possible, it became as large as the Earth itself—or I might take the Earth itself as the large ball—that *then* the attraction would become so powerful as to cause them to rush together in this manner [dropping the ivory ball]. You sit *there* upright, and I stand upright *here*, because we keep our centres of gravity properly balanced with respect to the earth; and I need not tell you that on the other side of this world the people are standing and moving about with their feet towards our feet, in a reversed position as compared with us, and all by means of this power of gravitation to the centre of the earth.

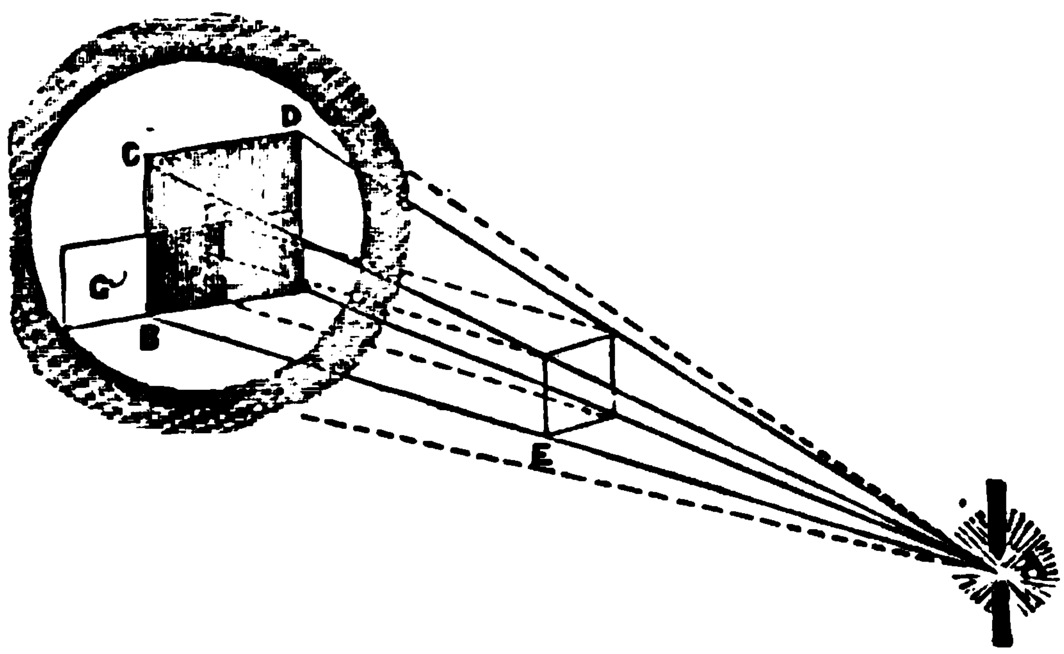
I must not, however, leave the subject of gravitation without telling you something about its laws and regularity; and first, as regards its power with respect to the distance the bodies are apart. If I take one of these balls and place it within an inch of the other, they attract each other with a certain power. If I hold it at a greater distance off, they attract with less power, and if I hold it at a greater distance still, their attraction is still less. Now this fact is of the greatest consequence; for, knowing this law, philosophers have discovered most wonderful things. You know that there is a planet, Uranus, revolving round the sun with us, but eighteen hundred millions of miles off; and because there is another planet as far off as three thousand millions of miles, this law of attraction, or gravitation, still holds good, and philosophers actually discovered this latter planet, Neptune, by reason of the effects of its attraction at this overwhelming distance. Now I want you clearly to understand what this law is. They say (and they are right) that two bodies attract each other *inversely as the square of the distance,*—a sad jumble of words until you understand them; but I think we shall

* From the Lond. Chemical News, No. 6.

soon comprehend what this law is, and what is the meaning of the "inverse square of the distance."

I have here (Fig. 1) a lamp A, shining most intensely upon this disc BCD, and this light acts as a sun by which I can get a shadow from

Fig. 1.

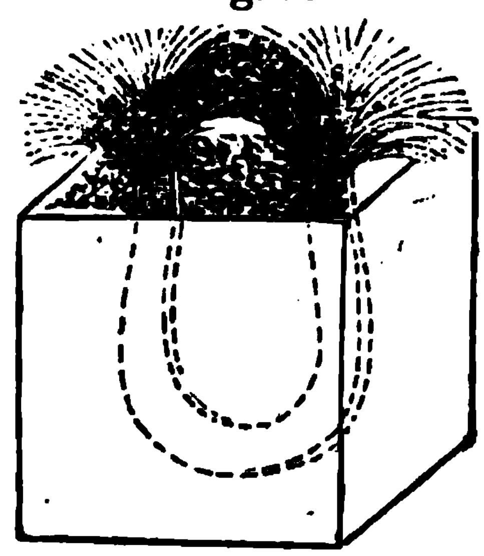


this little screen BF (merely a square piece of card), which, as you know, when I place it close to the large screen, just shadows as much of it as is exactly equal to its own size; but now let me take this card E, which is equal to the other one in size, and place it midway between the lamp and the screen; now look at the size of the shadow BD, it is four times the original size. Here, then, comes the "inverse square of the distance." This distance AE, is *one*, and that distance AB, is *two*, but that size E, being *one*, this size BD of shadow is *four* instead of *two*, which is the *square* of the distance; and if I put the screen at one-third of the distance from the lamp, the shadow on the large screen would be *nine* times the size. Again, if I hold this screen *here* at BF, a certain amount of light falls on it; and if I hold it nearer the lamp at E, *more* light shines upon it. And you see at once how much—exactly the quantity which I have shut off from the part of this screen BD, now in shadow; moreover, you see that if I put a single screen here at G, by the side of the shadow, it can only receive *one-fourth* of the proportion of light which is obstructed. That, then, is what is meant by the *inverse* of the square of the distance. This screen E, is the brightest because it is the nearest, and there is the whole secret of this curious expression *inversely as the square of the distance.* Now, if you cannot perfectly recollect that when you go home, get a candle and throw a shadow of something—your profile, if you like—on the wall, and then recede or advance, and you will find that your shadow is exactly in proportion to the *square* of the distance you are off the wall; and then if you consider how much light shines on you at one distance, and how much at another, you get the inverse accordingly. So it is as regards the attraction of these two balls, they attract according to the square of the the distance, inversely. I want you to try and remember these words, and then you will be able to go into all the calculations of astronomers, as to the planets and other bodies, and tell why they move so fast, and why they go *round* the sun without falling into it, with many other curious things.

Let us now leave this subject which I have written upon the board under the word FORCE—GRAVITATION—and go a step further. All bodies attract each other at sensible distances. I showed you the electric attraction on the last occasion (though I did not call it so); that attracts at a distance; and in order to make our progress a little more simple, suppose I take a few iron particles [dropping some small fragments of iron on the table]. There, I have already told you that in all cases where bodies fall, it is the *particles* that are attracted. You may consider these, then, as separate particles magnified, so as to be evident to your sight; they are loose from each other—they all gravitate—they all fall to the earth—for the force of gravitation *never* fails. Now, I have here a centre of power which I will not name at present, and when these particles are placed upon it, see what an attraction they have for each other.

Here I have an arch of iron filings (Fig. 2) regularly built up like an iron bridge, because I have put them within a sphere of action which will cause them to attract each other. See!—I could let a mouse run through it, and yet if I try to do the same thing with them *here* [on the table] they do not attract each other at all. It is *that* [the magnet] which makes them hold together. Now just as these iron particles hold together in the form of an elliptical bridge, so do the different particles of iron which constitute this nail hold together and make it one. And here is a bar of iron; why, it is only because the different parts of *this* iron are so wrought as to keep close together by the attraction *between* the particles, that it is held together in one mass. It is kept together, in fact, merely by the attraction of one particle to another, and that is the point I want now to illustrate. If I take a piece of flint and strike it with a hammer and break it thus [breaking off a piece of the flint], I have done nothing more than separate the particles which compose these two pieces so far apart, that their attraction is too weak to cause them to hold together, and it is only for that reason that there are now two pieces in the place of one. I will show you an experiment to prove that this attraction does still exist in those particles, for here is a piece of glass (for what was true of the flint and the bar of iron is true of the piece of glass, and is true of every other solid, they are all held together in the lump by the attraction between their parts), and I can show you the attraction between its separate particles, for if I take these portions of glass which I have reduced to a very fine powder, you see that I can actually build them up into a solid wall by pressure between two flat surfaces. The power which I thus have of building up this wall is due to the attraction of the particles, forming, as it were, the cement which holds them together; and so in this case, where I have taken no very great pains to bring the particles together, you see, perhaps a couple of ounces of finely pounded glass standing as an upright wall—is not this attraction most wonderful? *That* bar of iron

Fig. 2.



one inch square has such power of attraction in its particles—giving to it such strength—that it will hold up twenty tons weight before the little set of particles in the small space equal to one division across which it can be pulled apart, will separate. In this manner suspension bridges and chains are held together by the attraction of their particles, and I am going to make an experiment which will show how strong is this attraction of the particles—do not think me a harlequin or fairy. [The Lecturer here placed his foot on a loop of wire fastened to a support above, and swung with his whole weight resting upon it for some moments.] You see, while hanging here all my weight is supported by these little particles of the wire, just as in pantomimes they sometimes suspend gentlemen and damsels.

Now how can we make this attraction of the particles a little more simple? There are many things which if brought together properly will show this attraction. Here is a boy's experiment (and I like a boy's experiment).—Get a tobacco-pipe, fill it with lead, melt it, and then pour it out upon a stone, and thus get a clean piece of lead (this is a better plan than scraping it—scraping alters the condition of the surface of the lead). I have here some pieces of lead which I melted this morning for the sake of making them clean. Now these pieces of lead hang together by the attraction of their particles, and if I press these two separate pieces close together, so as to bring their particles within the sphere of attraction, you will see how soon they become one. I have merely got to give them a good squeeze, and draw the upper piece slightly round at the same time, and here they are as one, and all the bending and twisting I can give them will not make them separate again; I have joined the lead together, not with solder, but simply by means of the attraction of the particles.

This, however, is not the best way of bringing those particles together, we have many better plans than that—and I will show you one that will do very well for juvenile experiments. There is some alum crystallized very beautifully by nature (for all things are far more beautiful in their natural than their artificial form), and here I have some of the same alum broken into fine powder. In it I have destroyed that force of which I have placed the name on this board—COHESION, or the attraction exerted between the particles of bodies to hold them together. Now I am going to show you that if we take this powdered alum and some hot water, and mix them together, I shall dissolve the alum—all the particles will be separated by the water far more completely than they are here in the powder; but then, being in the water, they will have the opportunity as it cools (for that is the condition which favors their coalescence) of uniting together again and forming one mass.

Now having brought the alum into solution, I will pour it into this glass basin, and you will, to-morrow, find that those particles of alum which I have put into the water, and so separated that they are no longer solid, will as the water cools, come together and cohere, and by to-morrow morning we shall have a great deal of the alum crystallised out, that is to say, come back to the solid form. [The Lecturer

here poured a little of the hot solution of alum into the glass dish, and when the latter had thus been made warm, the remainder of the solution was added.] I am now doing that which I advise you to do if you use a glass vessel, namely, warming it slowly and gradually; and in repeating this experiment do as I do; pour the liquid out gently, leaving all the dirt behind in the basin; and remember that the more carefully and quietly you make this experiment at home, the better the crystals. To-morrow you will see the particles of alum drawn together, and if I put two pieces of coke in some part of the solution (the coke ought first to be washed very clean and dried), you will find to-morrow that we shall have a beautiful crystallization over the coke, making it exactly resemble a natural mineral.

Now how curiously our ideas expand by watching these conditions of the attraction of cohesion—how many new phenomena it gives us beyond those of the attraction of gravitation. See how it gives us great strength. The things we deal with in building up the structures on the earth are of strength—we use iron, stone, and other things of great strength; and only think that all those structures you have about you—think of the *Great Eastern*, if you please, which is of such size and power as to be almost more than man can manage—are the result of this power of cohesion and attraction.

I have here a body in which I believe you will see a change taking place in its condition of cohesion at the moment it is made. It is at first yellow, then it becomes a fine crimson red. Just watch when I pour these two liquids together—both colorless as water. [The Lecturer here mixed together solutions of perchloride of mercury and iodide of potassium, when a yellow precipitate of biniodide of mercury fell down, which almost immediately became crimson red.] Now, there is a substance which is very beautiful, but see how it is changing color. It was reddish-yellow at first, but it has now become red. I have previously prepared a little of this red substance, which you see formed in the liquid, and have put some of it upon paper. [Exhibiting several sheets of paper coated with scarlet biniodide of mercury.] There it is—the same substance spread upon paper, and there too is the same substance; and here is some more of it [exhibiting a piece of paper as large as the other sheets, but having only very little red color on it, the greater part being yellow], a *little* more of it, you will say. Do not be mistaken; there is as much upon the surface of one of these pieces of paper as upon the other. What you see yellow is the same thing as the red body, only the attraction of cohesion is in a certain degree changed; for I will take this red body, and apply heat to it (you may perhaps see a little smoke arise, but that is of no consequence), and if you look at it, it will at first of all darken—but see, how it is becoming yellow. I have now made it all yellow, and what is more it will remain so; but if I take any hard substance and rub the yellow part with it, it will immediately go back again to the red condition. [Exhibiting the experiment.] There it is. You see the red is not *put back*, but *brought back* by the change in the substance. Now [warming it over the spirit lamp] here it is becoming yellow again,

and that is all because its attraction of cohesion is changed. And what will you say to me when I tell you that this piece of common charcoal is just the same thing, only differently coalesced, as the diamonds which you wear. (I have put a specimen outside of a piece of straw which was charred in a particular way—it is just like black lead.) Now, this charred straw, this charcoal, and these diamonds, are all of them the same substance, changed but in their properties as respects the force of cohesion.

Here is a piece of glass [producing a piece of plate glass about two inches square], (I shall want this afterwards to look at and examine its internal condition)—and here is some of the same sort of glass differing only in its power of cohesion, because while yet melted it has been dropped into cold water [exhibiting a "Prince Rupert's drop" (Fig. 3)], and if I take one of these little tear-like pieces and break off ever so little from the point, the whole will at once burst and fall to pieces. I will now break off a piece of this. [The Lecturer nipped off a small piece from the end of one of the Rupert's drops, whereupon the whole immediately fell to pieces.] There! you see the solid glass has suddenly become powder, and more than that, it has knocked a hole in the glass vessel in which it was held. I can show the effect better in this bottle of water, and it is very likely the whole bottle will go. [A 6-oz. vial was filled with water, and a Rupert's drop placed in it with the point of the tail just projecting out; upon breaking the tip off, the drop burst, and the shock being transmitted through the water to the sides of the bottle, shattered the latter to pieces.]

Here is another form of the same kind of experiment. I have here some more glass which has not been annealed, [showing some thick glass vessels (Figure 4)], and if I take one of these glass vessels and drop a piece of pounded glass into it (or I will take some of these small pieces of rock crystal—they have the advantage of being harder than glass) and so will make the least scratch upon the inside, the whole bottle will break to pieces,—it cannot hold together. [The Lecturer here dropped a small fragment of rock crystal into one of these glass vessels, when the bottom immediately came out and fell upon the plate.] There it goes through, just as it would through a sieve.

Fig 3.

Fig. 4.

Now, I have shown you these things for the purpose of bringing your minds to see that bodies are not merely held together by this power of cohesion, but that they are held together in very curious ways. And suppose I take some things that are held together by this force, and examine them more minutely. I will first take a bit of glass, and if I give it a blow with a hammer I shall just break it to pieces. You saw how it was in the case of the flint when I broke a piece off; a piece of a similar kind would come off, just as you would expect; and if I were to break it up still more, it would be as you

have seen, simply a collection of small particles of no definite shape or form. But supposing I take some other thing, this stone for instance (Fig. 5) [taking a piece of mica], and if I hammer this stone I may batter it a great deal before I can break it up. I may even bend it without breaking it; that is to say, I may bend it in *one particular direction* without breaking it much, although I feel in my hands that I am doing it some injury. But now, if I take it by the edges I find that it breaks up into leaf after leaf in a most extraordinary manner. Why should it break up like that? Not because all stones do, or all crystals; for there is some salt—(Fig. 6)—you know what com-

Fig. 5. Fig. 6. Fig. 7.

mon salt is; here is a piece of this salt which by natural circumstances has had its particles so brought together that they have been allowed free opportunity of combining or coalescing, and you shall see what happens if I take this piece of salt and break it. It does not break as flint did, or as the mica did, but with a clean sharp angle and exact surfaces, beautiful and glittering as diamonds [breaking it by gentle blows with a hammer]; there is a square prism which I may break up into a square tube. You see these fragments are all square—one side may be longer than the other, but they will only split up so as to form square or oblong pieces with cubical sides. Now, I go a little further, and I find another stone (Fig. 7) [Iceland or calc-spar], which I may break in a similar way, but *not* with the same result. Here is a piece which I have broken off, and you see there are plain surfaces perfectly regular with respect to each other, but it is not cubical—it is what we call a rhomboid. It still breaks in three directions most beautifully and regularly with polished surfaces, but with *sloping* sides, not like the salt. Why not? It is very manifest that this is owing to the attraction of the particles one for the other being less in the direction in which they give way than in other directions. I have on the table before me a number of little bits of calcareous spar, and I recommend each of you to take a piece home, and then you can take a knife and try to divide it in the direction of any of the surfaces already existing. You will be able to do it at once—but if you try to cut it *across* the crystals you cannot; by hammering, you may bruise and break it up—but you cannot divide it into these beautiful little rhomboids.

Now I want you to understand a little more how this is—and for this purpose I am going to use the electric light again. You see, we cannot look into the *middle* of a body like this piece of glass. We

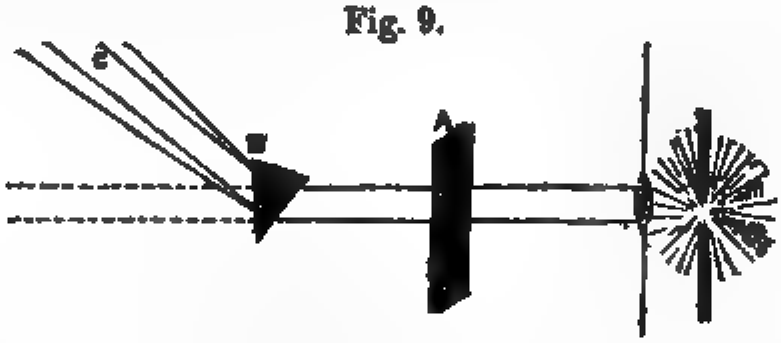
perceive the outside form, and the inside form, and we look *through* it, but we cannot well find out how these forms become so, and I want you, therefore, to take a lesson in the way in which we use a ray of light for the purpose of seeing what is in the interior of bodies. Light is a thing which is, so to say, attracted by every substance that gravitates (and we do not know anything that does not). All matter affects light more or less by what we may consider as a kind of attraction, and I have arranged (Fig. 8) a very simple experiment upon the floor

Fig. 8.

of the room for the purpose of illustrating this. I have put into that basin a few things which those who are in the body of the theatre will not be able to see, and I am going to make use of this power which matter possesses of attracting a ray of light. If Mr. Anderson pours some basin, the water will attract the rays of light downwards, and the piece of sealing wax will appear to rise up into the sight of those who were before not high enough to see over the side of the basin to its bottom. [Mr. Anderson here poured water into the basin, and upon the Lecturer asking whether anybody could see the silver and sealing wax he was answered by a general affirmative]. Now I suppose that everybody can see that they are not at all disturbed, whilst from the way they appear to have risen up, you would imagine the bottom of the basin and the articles that are in it were two inches thick, although they are only one of our small silver dishes and a piece of sealing wax which I have put there. The light which now goes to you from that piece of silver was obstructed by the edge of the basin when there was no water there, and you were unable to see anything of it; but when we poured in water, the rays were attracted down by it over the edge of the basin, and you were thus enabled to see the articles at the bottom.

I have shown you this experiment first, so that you might understand how glass attracts light, and might then see how other substances like rock salt and calcareous spar, mica, and other stones would affect the light; and if Dr. Tyndall will be good enough to let us use his

Fig. 9.



light again, we will first of all show you how it may be bent by a piece of glass (Fig. 9). [The electric lamp was again lit, and the beam of parallel rays of light which it emitted was bent about and decomposed by means of the prism.] Now here you see, if I send the light through

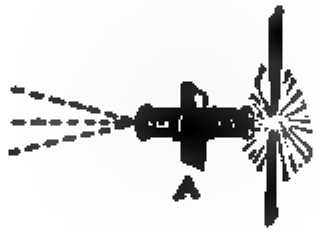
this piece of plain glass A, it goes straight through without being bent (unless the glass be held obliquely, and then the phenomenon becomes more complicated), but if I take this piece of glass B [a prism], you see it will show a very different effect. It no longer goes to that wall but it is bent to this screen C, and how much more beautiful it is now [throwing the prismatic spectrum on the screen.] This ray of light is bent out of its course by the attraction of the glass upon it. And you see I can turn and twist the rays to and fro in different parts of the room just as I please. Now it goes there, now here. [The Lecturer projected the prismatic spectrum about the theatre.] Here I have the rays once more bent on the screen, and you see how wonderfully and beautifully that piece of glass not only bends the light by virtue of its attraction, but actually splits it up into different colors. Now I want you to understand that this piece of glass [the prism] being perfectly uniform in its internal structure, tells us about the action of these other bodies which are not uniform—which do not merely *cohere*, but also have within them, in different parts, different *degrees of cohesion*, and thus attract and bend the light with varying powers. We will now let the light pass through one or two of these things which I just now showed you broke so curiously; and first of all I will take a piece of mica. Here you see is our ray of light—we have first to make it what we call *polarized*, but about that you need not trouble yourselves; it is only to make our illustration more clear. Here, then, we have our polarized ray of light, and I can so adjust it as to make the screen upon which it is shining either light or dark, although I have nothing in the course of this ray of light but what is perfectly transparent [turning the *analizer* round]. I will now make it so that it is quite dark, and we will in the first instance put a piece of common glass into the polarized ray so as to show you that it does not enable the light to get through. You see the screen remains dark. The glass then, internally, has no effect upon the light. [The glass was removed, and a piece of mica introduced.] Now, there is the mica which we split up so curiously into leaf after leaf, and see how that enables the light to pass through on to the screen, and how, as Dr. Tyndall turns it round in his hand, you have those different colors, pink, and purple, and green, coming and going most beautifully;—not that the mica is more transparent than the glass, but because of the different manner in which its particles are arranged by the force of cohesion.

Now we will see how calcareous spar acts upon this light,—that stone which split up into rhombs, and of which you are going to take a little piece home each of you. [The mica was removed, and a piece of calc-spar introduced at A.] See how that turns the light round and round, and produces these rings and that black cross (Fig. 10). Look at those colors, are they not most beautiful for you and for me? (for I enjoy these things as much as you do.) In what a wonderful manner they open out to us the internal arrangement of the particles of this calcareous spar by the force of cohesion.

And now I will show you another experiment. Here is that piece

of glass which before had no action upon the light. You shall see what it will do when we apply pressure to it. Here, then, we have our ray of polarized light, and I will first of all show you that the glass has no effect upon it in its ordinary state,—when I place it in the

Fig. 10.



course of the light, the screen still remains dark. Now Dr. Tyndall will press that bit of glass between three little points, one point against two, so as to bring a strain upon the parts, and you will see what a curious effect that has. [Upon the screen two white dots gradually appeared.] Ah! these points show the position of the strain—in these parts the force of cohesion is being exerted in a different degree to what it is in the other parts, and hence it allows the light to pass through. How beautiful that is—how it makes the light come through some parts and leaves it dark in others, and all because we weaken the force of cohesion between particle and particle. Whether you have this mechanical power of straining, or whether we take other means, we get the same result, and, indeed, I will show you by another experiment that if we heat the glass in one part it will alter its internal structure, and produce a similar effect. Here is a piece of common glass, and if I insert this in the path of the polarized ray, I believe it will do nothing. There is the common glass [introducing it]—no light passes through—the screen remains quite dark; but I am going to warm this glass in the lamp, and you know yourselves that when you pour warm water upon glass you put a strain upon it sufficient to break it sometimes—something like there was in the case of the Prince Rupert's drops. [The glass was warmed in the spirit lamp, and again placed across the ray of light.] Now you see how beautifully the light goes through those parts which are hot, making dark and light lines just as the crystal did, and all because of the alteration I have effected in its internal condition; for these dark and light parts are a proof of the presence of forces acting and dragging in different directions within the solid mass.

(To be Continued.)

Methods of Ripening Wine.

According to the *Cosmos*, M. Payen, a distinguished French chemist, has the credit of proposing the following methods of ripening wine:

First Method. Take a cask of wine, and expose it to cold in a clean

vat; remove every morning, for three or four days successively, the ice which has formed on the surface; the ice, when melted, will furnish *piquette;* and the remaining liquid will be an excellent wine.—Re-pour it into a cask; add to perfume it, say a quart of raspberry juice, or two cents worth of Florence flag-root powdered and first digested in wine, cork it up tight and keep it.—(*If you can.* ED. J. F. I.)

Second Method. In March or April take second-crop hay or straw; make a bed of it about 8 inches thick, upon which lay a first row of bottles corked and waxed; and build up the pile in this way: water the pile with common water so that the hay may ferment, rot, and dissolve. At the end of three or four months your wine will have the same flavor as though it had been three or four years in bottle.

Cosmos, March, 1860.

For the Journal of the Franklin Institute.

Cadmium. By B. Wood, M. D.

The properties of cadmium appear to have been less clearly determined by chemists and metallurgists than those of most other metals. Discrepancies exist in regard to it, while some of its most remarkable, if not most useful properties are not at all noticed, at least by the generality of authors, even when explicit and elaborate as to similar properties possessed by other metals. Our ordinary works on chemistry treat of the metal very briefly, as of little importance—one of the latest says, it "has *no* practical value in the arts:"—but if duly investigated it will be found, I think, to possess qualities highly useful to the arts as well as interesting to science.

The melting point of cadmium is variously stated by authors. Some place it indefinitely, "below a red heat." Overman in his Treatise on Metallurgy, marks it at 550° Fahr., and indicates 600° as the temperature at which the metal volatilizes. Brande, Dict. Science and Art, says "it fuses and volatilizes at a temperature a little below that at which tin melts." Webster, Manual of Chemistry, states that "it melts and volatilizes by a heat not much greater than that required to vaporize mercury." Most of our chemical text-books put its melting point at 442° (from Stromeyer). While the New American Cyclopædia, now in course of publication, places it, on the authority of Daniell, at 360° Fahr.

It would be interesting to determine this accurately. But the heat being too high for measurement by the mercurial thermometer, and having no other, I have only been able to judge approximately by comparative tests. Melted under similar conditions with other metals, I find the metal requires for its fusion nearly the same heat as lead. It is somewhat later in melting but on the other hand it appears to congeal a little the sooner, (which may be due to a difference in the conducting power of the two metals.) I should, therefore, place its melting point in round numbers at 600° Fahr., that of lead being placed by different authors, at 594°, 600°, and 612°. It volatilizes at a some-

what higher temperature, giving off orange-colored suffocating fumes, which, when inhaled too freely leave a disagreeable, sweetish, styptic sensation upon the *lips*, and an intolerable and persistent brassy taste in the mouth and fauces, with constriction of the throat, heaviness in the head, and nausea.

Of the general properties of cadmium as an ingredient in alloys, Overman, who I believe is high authority in metallurgy, and who, although too broad in some of his conclusions, is more rigidly exact in respect to the individual instances adduced than others that I have had the opportunity of examining, says:

"Cadmium is very soft and malleable and still all its alloys are brittle. Its combinations are not distinguished for fluidity." Again, "The combinations of platinum, copper, and other metals with cadmium, are brittle and hard." The cause of this he ascribes to "its volatile nature and want of affinity," which, recurring to the subject, he accounts for thus:

"When it is melted with any other metal there is a tendency on its part to evaporate; the slight affinity of cadmium for other metals causes a separation of its atoms from those of the other metal, and no intimate union can be formed. If, therefore, the alloy cools there are spaces between the crystals which have been occupied by the expanded atoms of cadmium, and in cooling, these are filled again; this causes brittleness." *Treatise on Metallurgy*, p. 465.

All this is strictly true of *some* of its combinations, such as the particular instances which he cites, although by no means of "all," as will presently be seen.

Other authors, although less explicit, are to a like import, ascribing a similar, general character to the metal, with examples in illustration, and without instancing any exceptions.

In a copy of Article on Alloys of Cadmium, from *Berthier's Traité des Essais*, Tome 2, p. 530, furnished me by the patent office as authority on the subject, I find it stated in general terms that "most of the alloys of cadmium are brittle;" the individual alloys cited are particularly characterized as brittle, and no mention is made of others.—The combination with mercury is thus described: "Cadmium unites with great facility with mercury, even when cold. The amalgam is of a silver white, and texture granular and crystalline. It can be obtained in octohedrons. It is hard and very fragile. Its density is greater than that of mercury. It fuses at 75° [centigrade.] It contains 0·217 of cadmium."

Combined in these proportions the compound will indeed be comparatively fragile; but one might be led to infer from this description that the metals combine in no other proportions. I have seen this particular form of amalgam cited by other authors when speaking of the combination of cadmium with mercury but without any illusion to other compounds of these metals; although they unite with facility in other proportions, forming amalgams particularly noteworthy as contrasted with those of other metals.

While it has been assumed as a general rule as above quoted, that

the combinations of cadmium are not distinguished for fluidity, I have not found its fluidifying properties in respect to certain metals and alloys noticed in any work to which I have had access. *Some* of its alloys indeed are *not* remarkable for fusibility but, rather for the reverse; such are its alloys with silver, antimony, and mercury, their melting point being but little lower or even higher than that of the mean of their constituents. But others are much more fusible than the mean, as its alloys with lead, tin, copper, bismuth, zinc. In certain instances it manifests this property in so eminent a degree that it is singular it should not, if known, have been explicitly stated in all professed descriptions of the metal. Bismuth holds a high rank among metals for its property of promoting fusibility in alloys, as is particularly remarked in all chemical text-books, and wherever the metal is treated of, its alloys with lead and tin being specially noted as extraordinary instances. But in some combinations cadmium displays this property more decidedly than even bismuth. The alloy composed of from one to two parts of cadmium, two parts of lead, and four parts of tin is more fusible than the corresponding alloy of two parts (or less) of *bismuth*, two of lead and four of tin. In smaller proportions its superiority is still more marked, requiring much less to produce the same effect, while it does not impair the tenacity and malleability of the alloy but confers hardness and general strength.

As to the brittleness which cadmium is said to communicate when combined with any other metals, the facts are, *some* of its alloys even with malleable metals *are* "brittle." But others are highly tenacious and malleable. Its alloys with gold, platinum, and copper, afford instances of the former. Its combinations with lead, tin, and to a certain extent with silver and mercury, are examples of the latter. An alloy of two parts silver and one of cadmium is perfectly malleable and very hard and strong; with equal parts of each it is also malleable but possesses less tenacity; but when mixed in the proportions of two parts of cadmium and one part of silver, it is brittle. Equal parts of cadmium and mercury form a tough and highly malleable composition; in the proportions of two parts of the latter to one of the former; the amalgam is nearly equal in malleability but possesses less strength. These mixtures are remarkable in view of the fact that most amalgams are exceedingly frail and brittle. A mixture of two or three parts of tin with one part of mercury is so fragile as almost to drop to pieces in handling: the amalgams with lead, bismuth, &c., are similar.

The fusibility of the compounds of cadmium and mercury is nearly that of the mean of their constituents, as indeed, appears to be the case with other amalgams. I do not perceive that mercury acts as a fluidifying agent in alloys—it does not strictly promote fusibility but serves merely to communicate of its own fluidity to the compounds in nearly the ratio in which it is employed; it does not, like cadmium, bismuth, &c., confer any new property in this respect. Being fluid at 39° below the zero of Fahrenheit's scale it will of course if it only retain its own property, reduce the melting point of the compounds into which it enters as an ingredient, below that of the metals with which it is united.

Most of the mixtures of mercury with other metals, although it may form certain definite compounds with them, indicate combination by simple solution and mechanical admixture rather than by chemical affinity. With cadmium, however, it exhibits a marked affinity, forming amalgams, or as they might be appropriately designated, *alloys* which possess distinctive characters, indicating a true chemical combination.

But I leave these speculations to professed chemists, hoping the points herein referred to may serve to incite attention to a subject which I think will repay investigation.

Nashville, June 14, 1860.

Specific Gravity of Spirits of Wine.

A Mr. Von Baumhauer has been led by three series of carefully conducted experiments to the conclusion that the densities usually adopted for the mixtures of alcohol and water, from the experiments of Gay-Lussac and others, are incorrect. By his report, it would seem that every precaution was taken to ensure the purity of the materials and accuracy in the results, and the following are his results as compared with those given by Pouillet. The standard of density is water at its maximum density, and the mixtures were made with absolute alcohol. The temperature was 15° Cent. (59° F.)

Per cent. of alcohol, by volume, in the mixture.	Pouillet.	Density. Experiment First Series.	Density. Experiment Second Series.
100	0·7940	0·7939	0·7940
95	·8161	·8119	·8121
90	·8339	·8283	·8283
85	·8495	·8438	·8432
80	·8638	·8576	·8572
75	·8772	·8708	·8708
70	·8899	·8837	·8838
65	·9019	·8959	·8963
60	·9133	·9079	·9081
55	·9240	·9193	·9196
50	·9340	·9301	·9302
45	·9432	·9394	·9400
40	·9515	·9485	·9491
35	·9587	·9567	·9569
30	·9648	·9635	·9636
25		·9692	·9696
20		·9746	·9747
15		·9799	·9800
10		·9855	·9855
5		·9919	·9918
0	·9991	·9991	·9991

Acad. des Sciences, Paris.

Preservation of Yeast.

M. de Changy states that by intimately mixing with any ferment, liquid or solid, a certain quantity of animal or vegetable charcoal, and drying the mixture either in a current of air or by rotation, a powder

is obtained which preserves all its fermentable properties for an unlimited time. Beer yeast treated in this way keeps its power for a long time, and the presence of the charcoal in the vat presents more advantages than objections.—*Cosmos.*

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*On the Production of Ozone by means of a Platinum Wire made Incandescent by an Electric Current.** By M. Le Roux.

If a platinum wire, not too large, be made incandescent by an electric current in such a manner that the ascending flow of hot air which has surrounded the wire comes in direct contact with the nostrils, an odor of ozone is perceived. The experiment may be made in the following manner:—A very fine platinum wire ($\frac{1}{10}$th to $\frac{1}{25}$th of a millimetre), 20 centimetres long, is taken; it is formed in any shape, and supported in an almost horizontal position in any suitable manner. A glass funnel of 2 or 3 litres is placed over this, so that the air has sufficient access to the wire. As the neck of the funnel is usually too narrow, it is cut so as to leave an aperture 2 or 3 centimetres in diameter, on which is adjusted a glass chimney of a suitable length; the object of which is to cool the gases heated by the wire. The wire is then made incandescent by means of twelve or fifteen Bunsen's cells. The gas issuing from the chimney is found to have the odor of ozone; iodized starch-papers are altered in a few minutes when placed over the chimney. In this case, the air passing over the incandescent wire undergoes a peculiar modification by which it acquires the properties of ozone; but whether this is effected by the electricity acting as a source of heat, or by its own proper action, must be reserved for further experiments.—*Comptes Rendus*, April 2, 1860.

* From the Lond., Edin., and Dub. Philosophical Mag., May, 1860.

Printing Fabrics in Imitation of Embroidery.†

M. Perrot has recently discovered a novel mode of ornamenting fabrics by the printing process, so as to produce an effect similar to embroidery. This process consists simply in printing, by the aid of rollers, any desired pattern upon a fabric, in a solution of gutta percha, previously bleached by the aid of chlorine, and dissolved by any of the well-known solvents. The fabric so printed is then passed through a box or casing containing woolen, cotton, silk, or other fine flock or colored powder, which adheres only to those parts impressed with the solution, and forms beautifully raised patterns and devices having a fine, soft, and velvety surface. This process recalls to our mind a very similar system which was patented as far back as 1850, by Mr. Auchterlonie, of Glasgow. Our readers will find a notice of Mr. Auchterlonie's system in our 3d vol., 1st series, at page 105, where they will be enabled to compare the two, and judge of their relative values. We have not seen any fabrics ornamented after M. Perrot's plan, but

† From the Lond. Practical Mechanic's Journal, May, 1860.

we inspected Mr. Auchterlonie's fabrics, and witnessed the process of ornamenting, and can speak with the greatest confidence of the success of the system.

New and Cheap Motors.

One of the March numbers of the *Cosmos* contains an enthusiastic editorial describing two new machines which are to revolutionize mechanics in France (when the use of the word becomes legal). We copy the substance of these as a specimen of the statements of men who profess the greatest horror of American exaggerations. The first is a steam-generator somewhat on the Perkins principle of generating steam by the injection of small quantities of water upon red hot surfaces. As so many persons, and among others so many Frenchmen, have done this before, all that the Abbè claims for his friend M. Testud de Beauregard, is the tinning the inside and outside of the boiler, and immersing it in a bath of melted tin; but these novelties, according to account, produce the following desirable results:—(we translate literally)—"Enormous reduction of bulk of the boiler; enormous diminution of the vaporizing surface; absolute impossibility of explosion; immense diminution in quantity of the feed-water; feed of distilled water from the condensation; no more calcareous scale; no more cleaning, or a simple cleaning with a brush; no more slowness in the boiling; no more waste of time; steam entirely dry without any water carried over; steam whose fixed temperature may be changed at pleasure from 200° to 1000°; useful employment of the exhausted steam (*vapeur morte*) for the generation of a new motive force; condensation as perfect as it can be with the production of a vacuum which adds the atmospheric pressure to that of the steam; a truly extraordinary regularity and stability of working; possibility of doubling, tripling, quadrupling, &c., the force obtained at any moment without any danger; a furnace naturally smoke-consuming whatever combustible is employed; the attending to the boiler made much less laborious; these are the incontestible advantages which the tin-bath generator realizes. It is adapted without any increased expense, without any necessity for troublesome or expensive alterations, to all steam engines; its constructors guarantee an economy of 50 per cent. on the fuel before used by them, however reduced this expense may have before been." Now if a handbill issued by a patentee in America had affirmed one-fourth the amount of utter absurdity contained in this extract from a journal which we regard as the very best scientific journal in France, how long would it be before the editors in France and England had ceased to denounce American extravagance and credulity?

But this, it appears, is no very great thing after all; a better machine is an explosion engine of M. Lenoir. This is described as a "conical cylinder (*cylindre conique*. The Abbè Moigne plumes himself on his mathematics) with an anterior and posterior compartment separated by a piston similar to those of a steam engine." The gas mixed at the rate of 5

per ct. with 95 of air, is admitted successively at each end and exploded by a spark from a small induction machine; thus blowing the piston back and forward. All this is well enough and old enough, but look at the results:—"With 5 per cent. of gas and 95 of air, the shaft and fly-wheel made 120 turns; the force produced was fully that of a horse power. A stout man operating on the circumference of the fly-wheel could not stop it; a mass of iron on the shaft was cut by the gouge or chisel without trouble. With this speed of 120 turns for twelve hours, the expenditure of gas is three cubic metres (106 cubic feet). Estimating the cubic metre at 6 centimes (1¼ cents) the expense per horse power per hour would be a centime and a half, that is about one-half that of the same force from coal.

It will be seen that gas is cheaper in Paris than here, but what is that to what follows. "We applaud with great pleasure the marvellous use which M. Isoard has made of superheated steam united with coal tar, to generate at an excessively low price, and as rapidly as is wished, torrents of very rich lighting gas. If we are not mistaken, the new gas will cost less than a centime per metre cube (56½ cents per thousand cubic feet), and as it requires only three cubic metres for a horse power for 12 hours; this force which in the most privileged countries, *in the county of Cornwall, near the mouth of the mines*, (when did the English coal mines get into Cornwall?) still costs five centimes (1 cent) will cost at Paris but one-fourth of this."

By the way, is not this the Saunders' Patent which has just exploded here, after a temporary notoriety obtained by means similar in character to these, but of less brilliancy?

In the same journal we find the following appreciation of the modification of Rhumkorff's Induction Apparatus by Ritchie, of Boston:

"An American physicist had brought to Paris an induction machine of a form somewhat differing from that adopted by M. Rhumkorff, and of larger dimensions, which, when excited by a sufficient battery, gave a continued series of sparks truly frightful, 13 inches long and more, and snapping with a formidable noise, less like electric discharges than like thunder-bolts. The professors and physicists who saw it in operation at M. Jules Duboscq's were astonished; it threw the apparatus of the celebrated artist into the shade, and for a moment it might be believed that they had been surpassed. M. Jamin, the Professor at the Polytechnic school, who was anxious to enrich the collections of that establishment with an extraordinary induction machine, gave a sort of challenge to M. Rhumkorff; he threatened to purchase the American machine, if within a very short interval he did not produce as powerful a one. M. Rhumkorff accepted the challenge, and his new apparatus, which costs less than half that of the American, is still more powerful; the sight of his sparks, or of his thunder-bolts, causes the boldest to tremble; with 6 couples of Bunsen, the sparks extend to the enormous distance of 16½ inches."

Now, omitting this extravagance about the thunder-bolts and terrors, which is unworthy of a serious writer on Science, let us establish the facts upon which the story is based. Prof. McCulloh, of Columbia

College, N. Y., took out with him one of Mr. Ritchie's instruments. Up to this time M. Rhumkorff had never got a spark over 3 inches in length; nor had Mr. Hearder, who improved Rhumkorff's instrument in England, got over 6. Mr. Ritchie's instrument is operated by 3 cells of a Bunsen battery, and the largest form (which we believe to be the one taken over by the Professor) is capable of giving sparks 18 inches in length.

M. Rhumkorff had (we believe) 6 months given him to produce his competing machine, and was allowed to examine Mr. Ritchie's instrument and even to dissect it; Mr. Ritchie never having attempted any secrecy as to the differences between the original instrument and what he modestly called a modification, although it is in some respects entitled to be considered a new instrument. If, then, M. Rhumkorff has not done better with 6 cups of battery than Ritchie has done with 3, the Abbé had better reserve his eloquence for future endeavors.

City Telegraph.

J. Herpin proposes to establish throughout Paris a system of telegraphs by which messages may be easily and rapidly sent from one part of the city to another. This would be a great convenience and a great benefit for business men. The proposed tariff is very cheap. For a simple message; by day, 2 cents; by night, from midnight to 6 A. M., 4 cents: message and answer, 3 cents by day, 5 cents by night. He calculates the probable yearly profits of the enterprise at $200,000, besides the employment given to laborers, lame and feeble persons, women, &c.—*Cosmos.*

*Transparent Ivory.**

The process for making ivory transparent and flexible is simply immersion in liquid phosphoric acid, and the change which it undergoes is owing to a partial neutralization of the basic phosphate of lime of which it principally consists. The ivory is cut in pieces not thicker than the twentieth part of an inch, and placed in phosphoric acid of a specific gravity of 1·181, until it has become transparent, when it is taken from the bath, washed in water, and dried with a clean linen cloth. It becomes dry in the air without the application of heat, and softens again under warm water.—*Druggists' Circular.*

* From the Lond. Chemical News, No. 16.

Self-Registering Hygrometer.

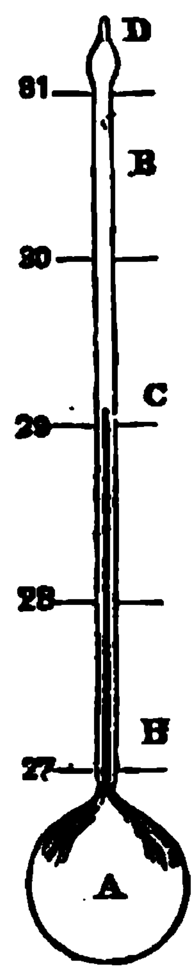
MM. Midre and Chaviere have improved the common hair hygrometer of Saussure by adding to it two loose hands, which are moved by a pin from the main index, so as to register maxima and minima. The improvement is very simple, but none the worse for that.

Cosmos.

*Description of an Hermetically-sealed Barometer.** By RICHARD ADIE, Liverpool.

When mounted on an ivory scale, this instrument resembles in size and portability a pocket thermometer of the medium or larger class.

It is constructed from a piece of thermometer tube, in which, in lieu of the spherical or cylindrical bulb formed for a thermometer, a cistern is made in the form of the section of a cylinder, 1·4 inches diameter and 1-10th of an inch thick, varying these measures according to circumstances; but generally the bulb has nearly the shape and dimensions of a half-crown. On the top of the tube there is an air cavity similar to that used in Dr. Rutherford's registering thermometer.



A. The cistern containing alcohol.
BB. The tube in which the height corresponding to the barometer is read.
C. The top of the alcohol column.
D. The air-cavity for correcting for temperature.
31 to 27. The figures to represent the height of the column C, with reference to the mercurial column.
Sub-divisions between each inch are added so as to read off to ·02.

The influence of change of temperature is got rid of by trial and adjustment of each instrument; so that the expansion of the air in the upper cavity will counterbalance the expansion of the liquid in the cistern. This correction for temperature applies only to the condition of equal heating of the instrument throughout. When it is well done, an instrument is obtained, which is extremely sensitive to any change of atmospherical pressure.

If dipped in water at the temperature of the air, the column in the tube immediately rises to show the increase of pressure. When carried from one story of a house to another, the change is noticed as the stairs are ascended. In the beginning of last April, I put one of the barometers in the corner of the compartment of the railway carriage in which I was traveling, from Liverpool to Edinburgh, where it indicated regularly the extensive changes from the sea level which that line of route contains.

The hermetically-sealed barometer which I have found to work best, is filled with colored alcohol; the column in the tube moving through about 1·5 inches for every inch of the mercurial barometer.

Filled with mercury, instruments corrected for temperature were obtained to move through half an inch for every inch of the barometer; but, in point of mobility, they were much inferior to alcohol-filled tubes.

Filled with ether, an instrument corrected for temperature could not be obtained in combination with delicacy of indication; but if the

* From the Lond. Quar. Jour. of the Chemical Society, April, 1860.

correction for temperature be dispensed with, and a place can be found for the barometer where the changes of temperature are small, ether, in an hermetically-sealed tube of the kind described, would furnish a most minute measure of changes in atmospheric pressure.

A tube filled with water did not act with delicacy, from the want of mobility in the fluid.

In the hermetically-sealed barometer, the reading may be much disturbed by unequal heating, when the instrument is held in the hand, or the sun allowed to shine on a portion of it. This can in a degree be prevented by the skill of the observer, with the interposition of non-conductors, and when carried by holding the instrument suspended by a cord, rather than keeping it in the pocket or hand. When the indication has been disturbed by unequal heating, it must remain suspended fifteen or twenty minutes before a reliable reading can be made.

Thin Cast Iron. By WM. FAIRBAIRN, Esq., F. R. S., &c., President, in the Chair.

From the Lond. Chemical News, No. 19.

The President exhibited two large pans of cast iron, procured by Mr. Worthington from China, where they are used for boiling rice. The metal, which is at the strongest part only one-tenth of an inch in thickness, possessed considerable malleability. The President remarked that the art of making such large castings of thin metal, was unknown in England.—*Proc. Manchester Lit. and Philo. Soc.*

Electro Copies of Engraved Steel Plates. By HENRY BRADBURY.

From the Journal of the Society of Arts, No. 389.

SIR:—Through the medium of the *Journal of the Society of Arts*, in July last, I made known the result of my endeavors to deposit pure nickel upon the surface of engraved copper plates. This I have continued to do with marked success. The deposit has nearly the appearance of silver in color, possesses almost the hardness of iron, is free from oxidation by air, resists the action of the ordinary acids, and, being easy of manipulation and inexpensive, is well worthy of attention. Each coating will furnish 5000 impressions and upwards. It is so hard as to stand the free use of the burnisher, and its texture is so fine as not to show the worn away portions of the deposit after each successive coating.

Finding the deposit so beautifully fine in texture and polished in surface, it occurred to me that if an engraved steel plate were covered with such a deposit, the plate might safely be immersed in a solution of sulphate of copper, and a metallic matrix be produced direct from it, without the risk of injury from the action of the acid of the solution. I have tried this with complete success, and have found (as might be supposed) that an electro copy of a steel plate thus obtained is very superior to one made from a matrix of gutta percha or other plastic composition. The engraved plate, however, must be quite free from under-cut lines.

12 and 13 Fetter Lane, Fleet Street, May 2, 1860.

Fusion of Platinum.

M. H. Sainte-Claire Deville continues to announce his fusion of platinum as though there were something new in it. In this city it has been worked in this way in large masses for years, by Mr. Bishop, formerly assistant to Dr. Hare. And, by the way, as Prof. Deville continues to find the density of iridium 18, it is evident that his fusion of that metal must be very imperfect, for Drs. Hare and Boyè found 21·8, and the latter was not free from air-bubbles. Iridium is, therefore, the heaviest metal yet known.

Clarifying Coal Oils.

From the Lond. Chemical News, No. 16.

Messrs. Dumoulin and Cotelle have been making a series of experiments with a view of rendering heavy oils suitable for ordinary lighting purposes, and have succeeded in producing a magnificent light, free from smoke and smell, and adapted in all respects for burning in a room. The following is their process:—In a close vessel are placed 100 lbs. of crude coal oil, 25 quarts of water, 1 lb. of chloride of lime, 1 lb. of soda, and half a pound of oxide of manganese. The mixture is violently agitated and allowed to rest for 24 hours, when the clear oil is decanted and distilled. The 100 lbs. of coal oil are to be mixed with 25 lbs. of resin oil; this is one of the principal points in the manipulation: it removes the gummy parts from the oil and renders them inodorous. The distillation spoken of may terminate the process, or the oils may be distilled before they are defecated and precipitated.—*Le Génie Industriel.*

On the Composition of Water obtained from the Coal-strata, Bradford Moor, Yorkshire. By F. A. Abel, Esq.

From the Lond. Ed. and Dub. Phil. Mag., May, 1860.

The analysis of a sample of water from the above source was undertaken a short time since with the view to ascertain whether it was adapted to general domestic purposes. The results furnished by the examination appeared of sufficient interest to warrant their publication.

Two samples of the water collected at the mouth of a coal-pit, at an interval of about one month (the separate analyses of which furnished thoroughly concordant results), were submitted to me officially for examination by Lieutenant-Colonel Hamley, Commanding Royal Engineer at York, who informed me that the water, which is highly esteemed in the neighborhood for drinking and culinary purposes, is raised from coal-pits, at a depth of about 200 feet beneath Bradford Moor—an abundant and regular supply being obtained.

The specific gravity of the water was 1000·78 at 60° F. Its reaction was powerfully alkaline, and its flavor was brisk and agreeable.

The proportion of solid matter obtained on evaporation amounted to 44·1 grains in an imperial gallon, of which by far the largest proportion consisted of carbonate of soda.

The alkalinity of the boiled water was determined by means of standard sulphuric acid, and found to be equivalent to a proportion of 30·76 grains of carbonate of soda in an imperial gallon.

The result obtained by the direct determination of the carbonic acid, corresponded accurately to the proportion required by theory to hold in solution the whole of the lime and magnesia in the water, and to form bicarbonate with the amount of soda represented by the number above quoted.

The following statement represents the proportions of the various constituents existing in solution in an imperial gallon of the water:—

Bicarbonate of soda,	43·53
Sulphate of soda,	7·50
Chloride of sodium,	1·34
Sulphate of potassa,	0·31
Phosphate of lime,	trace.
Carbonate of lime,	1·90
Carbonate of magnesia,	0·80
Organic matter,	1·20

Carbonic acid, holding the carbonates of lime and magnesia in solution, 1·25 grain = 2·642 cubic inches at 60° F.

The absence of nitric acid, ammonia, silicic acid, alkaline sulphides, and oxide of iron was established by special examinations.

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*A Composition named Zeiodelite, a kind of Paste which becomes as hard as Stone, is unchangeable by the Air, and being proof against the action of Acids, may replace Lead and other substances for various uses.** JOSEPH SIMON, 1859.

Zeiodelite is made by mixing together 19 lbs. of sulphur and 42 lbs. of pulverized stoneware and glass. The mixture is exposed to a gentle heat, which melts the sulphur, and then the mass is stirred until it becomes thoroughly homogeneous, when it is run into suitable moulds and allowed to cool. This preparation is proof against acids in general, whatever their degree of concentration, and will last an indefinite time. It melts at about 120° Centigrade, and may be re-employed without loss of any of its qualities, whenever it is desirable to change the form of an apparatus, by melting at a gentle heat and operating as with asphalte. At 110° Centigrade it becomes as hard as stone, and therefore preserves its solidity in boiling water. Slabs of zeiodelite may be joined by introducing between them some of the paste heated to 200° Centigrade, which will melt the edges of the slabs, and when the whole becomes cold it will present one uniform piece. Chambers lined with zeiodelite in place of lead, the inventor says, will enable manufacturers to produce acids free from nitrate and sulphate of lead. The cost will be only one-fifth the price of lead. The compound is also said to be superior to hydraulic lime for uniting stone, and resisting the action of water.

* From the Lond. Chemical News, No. 14.

For the Journal of the Franklin Institute.

Particulars of the Steamer Kilauea.

Hull built by Paul Curtis. Machinery by Atlantic Works, Boston, Mass. Owners, C. A. Williams & Co. Intended service, at the Sandwich Islands.

Hull.—Length on deck, 130 ft. 8 ins. Breadth of beam (molded), 26 ft. Depth of hold, 10 ft. Do. to spar deck, 16 ft. 6 ins. Frames—molded, 13 ins.—sided, 12 to 14 ins.—apart from centres, 30 ins., and strapped with diagonal double braces, $3\frac{1}{2}\times\frac{3}{4}$ in. Draft, forward and aft, 10 ft. Tonnage, 398 tons. Area of immersed section at load draft of 10 ft, 225 sq. ft. Masts, two—Rig, Brigantine.

Engines.—Vertical direct-acting. Diameter of cylinder, two of 26 ins. Length of stroke, 3 ft. Maximum pressure of steam, 25 lbs. Cut-off, ordinarily one-fourth. Maximum revolutions at above pressure, 55.

Boiler.—One—Return flue. Length, 28 ft. Breadth, 7 ft. 9 ins. Height, exclusive of steam chimney, 8 ft. 9 ins. Number of furnaces, two. Breadth do., 3 ft. 4 ins. Length of grate bars, 6 ft. 3 ins. Number of flues, above, 4, below, 10. Internal diameter do., above, 1 ft. 6 ins., below, 8 of 10 ins. and 10 of 18 ins. Length do., above, 22 ft. 8 ins., below, 15 ft. 11 ins. Diameter of smoke pipe, 3 ft. 3 ins.

Propellers.—Diameter of screw, 9 ft. Length do., 3 ft. 6 ins. Pitch do., 21 to 23 ft. Number of blades, three.

C. H. H.

Specification of a Patent granted to Barnabas Wood, of Davidson County, State of Tennessee, for an Improved Alloy or Metallic Composition suitable for a Metallic Cement in the manufacture of Tin, Pewter, and other metals; also useful for casting and other purposes.—Dated March 20th, 1860.

The object of my invention being to produce an alloy possessing great fusibility in connexion with the requisite tenacity and malleability suited for certain uses; I effect this object by the employment of cadmium in suitable proportions in combination with certain proportions of lead and tin: by which means I have produced an alloy which is superior to others in use in respect to the joint qualities above mentioned, and which, as a metallic cement or solder in fabricating wares from certain metals, is an improvement upon all others. It is claimed as an improvement upon the ordinary solders especially for soldering metals consisting essentially of tin, such as pewter and other of the more fusible combinations of tin employed in the arts; and in general in all those cases which require an easily melted, and highly tenacious and malleable solder.

It consists of the following proportions, which may be somewhat modified in various ways without substantially modifying the result, to wit:

Cadmium from one to two parts; lead two parts; tin four parts; the result as to fusibility and tenacity being nearly identical whether the cadmium be used in the larger or smaller ratio.

This alloy possesses great strength and tenacity, is perfectly malleable, and melts at a temperature somewhat under 300° F., being

some 50° or 60° below the melting point of the most fusible mixture of lead and tin used for solder; and is not inferior in other qualities. And in the essentials of tenacity and malleability it is superior to any of the so-called "bismuth solders" which melt at as low a temperature. Its qualities render it likewise superior to any other alloy for casting and modeling purposes, in certain cases, as will be at once evident to those versed in the business.

The specimen marked "No. 3" forwarded Oct. 31st, 1859, consists of one part cadmium, one part lead, and two and a half parts tin. Of the additional specimens, No. 4 contains two parts cadmium, two lead, and four tin; and No. 5, one part cadmium, two parts lead, and four tin.

For greater fusibility to suit particular cases, mercury may be added, although its tendency is, especially if used in large proportion, to impair the quality of tenacity, according as it improves that of fusibility. But it may be used in quantity at least equal to that of the cadmium without sensible detriment, while three or even four times that amount will not so destroy the useful qualities of the composition but that it may be used to advantage as a solder for certain cases, thereby lowering its melting point to nearly the temperature at which water boils.

The greatest fusibility is obtained when cadmium is used in the proportions of the formula above named, or in the ratio of one-fourth to one-eighth of the joint quantity of lead and tin; but I do not confine myself to this ratio, as the cadmium, for economy, may be considerably reduced, say to one-tenth or one-twelfth of the other two metals, without materially diminishing this quality of the alloy for practical use.

Cadmium may be used upon the same principle to improve the ordinary tinner's solder also called "fine solders," consisting essentially of tin alloyed with lead in the proportion of about one part lead to two or three parts tin; being used in the ratio aforesaid in respect to the sum of these metals, thereby conferring greater fusibility than a like ratio of bismuth, without, like bismuth, impairing the qualities of tenacity and malleability.

The same holds in respect to the combinations of lead, tin, and bismuth, or "bismuth solders" in the more fusible forms of which, the use of cadmium, according to the same principle, will produce results not hitherto obtained, and of decided benefit.

In particular, those mixtures of lead, tin, and bismuth which melt at, or somewhat under, the temperature of boiling water, and which in consequence of this extreme fluidity are known by the common name of "fusible metal," may, by the means indicated, be greatly improved in this quality without detriment to other useful qualities—the use of cadmium in any form in these mixtures to an amount equal to one-fourth, or one-eighth of the amount of lead and tin in them producing about the greatest attainable fusibility; although to insure the best results in respect to other qualities, as tenacity and pliability, it is better to use a little more lead and less tin than stated in the usual formulas of "fusible metal." I generally use the following proportions where the greatest fusibility is required, to wit:—cadmium one to two parts, tin two parts, lead four parts, bismuth seven to eight parts; the alloy

in these proportions melting at about 160° F., being some 40° or 50° below the melting point of the said "fusible metal" and not inferior in other qualities for the purpose of a metallic cement. The specimen marked "No. 1", contains the larger proportion of cadmium, consisting of cadmium 56 parts, tin 59 parts, lead 103½ parts, bismuth 212 parts, being combined according to the chemical equivalents of the ingredients, conceiving the union to be more intimate and perfect—although subsequent experiment has not demonstrated any practical advantage to result from such nice adjustment of proportions.

When the cadmium constitutes from one-tenth to one-twelfth of the joint amount of lead and tin, the melting point will be about 170° or 180° F., being low enough for general use in most cases.

These proportions may be somewhat varied without materially modifying the result. The proportions of cadmium and bismuth remaining the same, those of the lead and tin may be greatly varied in respect to each other, provided they jointly hold a similar ratio to the whole. Thus for greater softness the lead may be employed in a much greater excess over the tin than stated in the formula, and for greater hardness and rigidity, the tin may preponderate over the lead.

This alloy may be used as a cement for very fusible alloys, such as the "white metal" used for bells, the *cliché* of the French, and the so-called "fusible metal" above named; also for light wares of pewter, &c., and as a convenient temporary cement; also for light castings requiring a more fusible material than the bismuth alloys; not being liable to the objections appertaining to the amalgams resorted to in such cases.

Its melting point may be lowered by adding mercury, which, in quantity equal to one or two parts of the cadmium, is less objectionable than in alloys without cadmium.

For greater tenacity with a melting point similar to that of the "fusible metal" before mentioned, a larger proportion of lead should be used, so that this metal shall equal or somewhat exceed the quantity of bismuth.

My mode of compounding the ingredients possesses nothing peculiar; they may be melted all together and mixed by stirring, or melted separately and poured together. I usually melt the cadmium and lead together in one vessel, and the tin, or tin and bismuth, in another, pouring them together when melted, and mixing thoroughly by pouring the whole a few times from vessel to vessel. Mercury when used is added to the melted alloy, mixing as before.

Nor is my manner of using the composition peculiar. The parts of the metals to be cemented are touched with a solution of chloride of zinc, and the solder applied as usual, and fused by the application of heat in any of the ordinary modes. In casting, when used for taking casts or moulds from other fusible metals, these should be brushed over with black lead, lamp black, India ink, or other pigment, to prevent adhesion. A solution of logwood or red sanders in alcohol is very convenient for the purpose.

I do not claim the combination of lead and tin, or of lead, tin, and

bismuth, in the proportions specified, nor any other, separate and apart from cadmium. Nor do I claim any results that have been produced by any of the combinations referred to apart from cadmium, whether that of fusibility or any other, nor any merely equivalent results that may have been hitherto produced by other combinations. I do not claim the use of cadmium as an alloy, or as an ingredient in alloys, to be any thing new, nor its use in connexion with any of the metals specified for the purpose of producing any results in alloys other than those described. I confine myself to its use in the ratio substantially as specified in combination with the metals herein specified in the proportions of the said metals substantially as set forth, so as to produce an improvement in alloys whether in the qualities of fusibility and tenacity jointly, or of either (separately), but without practical detriment to the other, so as to produce a better article for use as a metallic cement, and for certain other uses.

What I therefore claim as my invention is,

The composition of matter, or alloy, consisting of the following proportions of cadmium, lead, and tin, or any modification thereof substantially as indicated so as to produce a similar result in alloys, to wit: cadmium from one to two parts, lead two parts, tin four parts, possessing the properties and advantages as herein described, and that may be used as a metallic cement, and for other purposes, and to which also mercury may be added, as set forth, to modify the result for particular cases.

I also claim as a further application of the same principle embodied in the production of the aforesaid alloy, the composition of matter or alloy consisting of from one to two parts cadmium, two parts tin, four parts lead, and seven or eight parts bismuth, or any modification thereof as herein specified and indicated so as to produce an alloy as described, useful as a cement and for other purposes as set forth, and to which also mercury may be added as stated.

What I claim as new in either case being the herein specified improvement in alloys produced by using cadmium in the ratio and manner herein described, in combination with the metals specified in the proportions thereof substantially as set forth.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM MAY 1, TO MAY 31, 1860.

Air Engine,—Compressed	Dana Bickford,	Westerly,	R. I.	15
Amalgamator,	J. A. Brock,	Chicago,	Ill.	1
Auger,—Hollow	Nye and Haviland,	Elmira,	N. Y.	22
Axle Boxes,	H. L. Castile,	Memphis,	Tenn.	15
——————,—Making	A. E. Smith,	Brouxville,	N. Y.	8
Ballot-box,	G. L. Bailey,	Portland,	Me.	22
Bands for Machinery,	J. H. Clifton,	Newcastle,	Penna.	22
Bark Mills,	William Tansley,	Salisbury Cent.	N. Y.	29
Barometers,	H. A. Clum,	Auburn,	"	29
Barrels,—Tools for Opening	David Snedeker,	City of	"	8

Basket, .	J. K. Park, .	Marlboro',	Mass.	1
Bayonet Scabbards,—Manuf. of	Emerson Gaylord,	Chicopee,	"	15
————,—Frog for	William Hoffman, .	Solano co.,	Cal.	8
Bed Bottom, .	L. W. Buxton, .	Nashua,	N. H.	8
Bedstead Fastening,	Richard Hubbard, .	Milton,	Ind.	15
———— .	Purches Miles, .	New Haven,	Conn.	15
————,—Folding	Edward Cotty, .	Brooklyn,	N. Y.	1
Bedsteads,—Invalid .	A. W. Chase, .	Ann Harbor,	Mich.	15
Bee-hives, .	J. S. Black, .	Bloomfield,	Ky.	15
Beer Powders, .	John McKellar, .	Thomaston,	Me.	15
Bill of Fare, .	William A. Bury,	Grosse Isle,	Mich.	8
Billiard Table Pocket-irons,	J. P. Ellicott, .	Washington,	D. C.	1
——— Tables,—Chalk-holder	" .	"	"	22
Boats,—Suspending .	C. H. Hasker, .	Portsmouth,	Va.	29
Bolt,—Flush .	William R. Carnes,	Roxbury,	Mass.	22
Bonnet Frames,—Clamp for	H. A. Reynolds, .	City of	N. Y.	1
Bonnets, .	A. Henri, .	Louisville,	Ky.	1
Book-binding, .	Thomas Towndrow, .	City of	N. Y.	29
Boot and Shoe Soles,—Burnish.	E. T. Ingalls, .	Haverhill,	Mass.	8
————,—Fill'g for	E. N. Foote, .	Saratoga Spr's,	N. Y.	1
Boots & Shoes,—Jointed Tip for	G. A. Mitchell, .	Turner,	Me.	22
————,—Skiv. Counters	W. A. Bacon, .	Campello,	Mass.	29
————,—Wooden Soles	Alexander Hanvey,	Steubenville,	Ohio,	1
Bosom Expanders, .	Church and Ellsworth,	Birmingham,	Conn.	8
Brushes, .	William Tusch,	Brooklyn,	N. Y.	22
Brush,—Hair .	J. R. Ingersoll, .	City of	"	22
Buildings,—Machine for Moving	Samuel Wells, .	Elmore,	Ohio,	22
Butt Hinge, .	J. E. Shields, .	Washington,	D. C.	29
Butter,—Machine for Printing	Miller and Wiegand,	Philadelphia,	Penna.	22
——— Worker, .	Lydia W. Stiles, .	Brooklyn,	Ohio,	15
Camp Stool, .	J. W. Willett, .	Wareham,	Mass.	22
Canal Locks,—Gates for	S. J. Seely, .	Albany,	N. Y.	8
Cane Juice,—Defecating	E. H. Wheeler, .	New Orleans,	La.	8
Canals,—Auto. Draw-bridges for	G. C. Bovey, .	Chillicothe,	Ohio,	8
Candle Mould Boxes, .	G. A. Stanley, .	Cleveland,	Ohio,	8
——— Moulding Apparatus,	" .	"	"	8
Cane Juice,—Clarifying	P. Marcelin & E. Eude,	New Orleans,	La.	22
Caoutchouc,—Vulcanizing	S. W. Warren, .	City of	N. Y.	22
Caps,—Forming Seamless Felt	J L Bridge & W B Lodge,	Vernon,	"	8
——,—Making Sheet Metal	Orrin Newton, .	Pittsburgh,	Penna.	22
Car Brakes, .	H. A. Mears, .	Pecatonica,	Ill.	1
———— .	E. F. Jewett, .	Plainville,	Ohio,	1
—— Couplings, .	J. S. Vaughan, .	Alexandria,	Va.	22
—— Seats, .	C. A. McEvoy, .	Richmond,	Va.	8
—— Springs, .	William Kingsbury,	City of	N. Y.	8
—— Wheels, .	S. P. Smith, .	Troy,	"	29
—— Windows,—Sash-support,	H. K. Smith, .	Philadelphia,	Penna.	29
Cars for Transport'g Cattle, &c.,	Lee Swearingen, .	Valley Riv. F's,	Va.	29
Carpet-cleaner, .	H. L. Nichols, .	City of	N. Y.	22
Cattle,—Apparatus for Breachy	J. P. Ledy & W. Boyers,	Mt. Carroll,	Ill.	15
Cement, .	Horace Billings,	Beasdstown,	"	1
——— .	Charles Fricke, .	Mobile,	Ala.	1
——— .	" .	"	"	29
Cements,—Silicated	G. E. Vanderburgh,	Mamaraneck,	N. Y.	29
Chimney Cowl, .	George Millard, .	Waterbury,	Conn.	15
Churn, .	W. B. Gordinier,	Coudersport,	Penna.	8
——— .	R. G. Holmes, .	Worcester,	Mass.	8
——— .	G. H. Van Vleck,	Buffalo,	N. Y.	8
——— .	J. W. Evans, .	Forsyth,	Ga.	29
——— .	D. M. Woodin, .	Brandon,	Wis.	29
Cigars,—Machines for Making	Thomas Thorp, .	City of	N. Y.	1
Clocks Vertically,—Adjusting	J. F. Keeler, .	Cleveland,	Ohio,	1

Cloth,—Machinery for Drying	Bezaleel Sexton, .	Albany,	N. Y.	8
Clothes-frame, .	J. Fraser, .	Rochester,	"	15
Coffins, .	Carter and Jones, .	City of	"	29
Coke,—Desulphurizing	George Nock, .	Pittsburgh,	Penna.	29
Corn Planters, .	William C. Banks, .	Como Depot,	Miss.	1
——— .	" .	"	"	1
——— .	Amos Seaman, .	Winnebago co.,	Ill.	1
——— .	J. H. Bonham, .	Elizabethtown,	Ohio,	22
——— .	A. Hayes & J. Vancuren,	Chenoa,	Ill.	22
——— .	Joel Lee, .	Galesburgh,	"	22
——— .	B. T. Stowell, .	Quincy,	"	22
——— .	John Johnson, .	Naples,	"	29
——— .	J. C. Moore, .	Peoria,	"	29
—— Shellers, .	J. G. Putnam, .	Tioga,	Penna.	22
Cotton,—Machines for Cleaning	John Gilmore, .	New Orleans,	La.	22
——— Bales,—Iron Ties for	Walter Stewart,	Natchez,	Miss.	1
———	Wm. S. Loughborough,	Rochester,	N. Y.	8
———,—Locks for	A. P. Merrill, Jr., .	Natchez,	Miss.	22
———,—Metal Ties for	James Aiken, .	"	"	1
——— Presses, .	Y. F. Wright, .	Green Hill,	Ga.	1
——— .	M. M. Jones, .	Morrisville,	N. Y.	15
——— Seed Planters, .	N. E. Badgley, .	Gadsden,	Ala.	1
Counter Shaft,—Arrangement of	G. W. Davis, .	Brooklyn,	N. Y.	22
Couplings for Shafting, .	Samuel Hall, .	City of	"	29
Cow-milkers, .	L. O. Colvin, .	Cincinnatus,	"	22
——— .	" .	"	"	29
Cultivator Teeth, .	D. B. Rogers, .	Pittsburgh,	Penna.	8
Cultivators, .	John Neff, Jr., .	Pultney,	N. Y.	8
——— .	R. P. Van Horne,	Gratiot,	Ohio,	29
———,—Hand	D. C. Jordan, .	Center Port,	N. Y.	22
Cup and Stand,—Metallic	S. J. Ladd,	Providence,	R. I.	8
Curtain Fixture, .	J. F. Hall, .	Bangor,	Me.	22
Dentists,—Moulds for metal dies,	F. Y. Clark, .	Savannah,	Ga.	22
Digging Machines,	A. A. Garver, .	Mechanicsb'gh,	Penna.	22
Ditching Machines, .	Benedict and Cummings,	W. Springfield,	"	15
———	C. O. West and others,	Martinsville,	Ohio,	15
——— .	John Masters, .	Waukegan,	Ill.	22
Door Fastener, .	John Lightfoot, .	Cold Spring,	Ky.	8
—— Latch, .	R. L. Underhill, .	Bath,	N. Y.	22
—— Lock, .	Henry Lockwood,	City of	"	1
—— Plate,—Glass .	Montague & Townsend,	New Bedford,	Mass.	22
Drain Tiles,—Mode of Laying	H. F. Baker, .	Centreville,	Ind.	1
Drains,—Cement .	Benjamin Livermore,	Hartford,	Vt.	1
Dress Hook, .	J. W. Strange, .	Bangor,	Me.	8
Drill,—Hand .	J. H. Parker, .	Boston,	Mass.	15
——— .	" .	"	"	15
Dumb-bells, .	D. F. Savage, .	"	"	29
Dumping Wagons, .	Tolhurst and Sartwell,	Liverpool,	Ohio,	8
Egg-beater, .	Frederick Ashley, .	City of	N. Y.	1
Elastic Cloth,—Manufacture of	H. H. Day, .	"	"	29
Electrodes,—Insulator for	Engler and Krauss, .	Paris,	France,	15
Embroidery Sewing Stand,	Dana Bickford, .	Westerly,	R. I.	1
Engraving Rollers,—Mach's for	William Shields, .	Manchester,	Engl'd,	15
Evaporating Apparatuses,	Isaac Sherman, .	Cleveland,	Ohio,	22
———	T. J. Price, .	Industry,	Ill.	15
——— Liquids, .	Ernst Constantine,	City of	N. Y.	8
———	George Stevenson, .	Zionsville,	Ind.	8
Fat,—Machines for Cutting	J. M. Hunter, .	City of	N. Y.	8
Fats into Fatty Acids,—Decom.	R. A. Tilghman, .	Philadelphia,	Penna.	15
Feathers,—Renovating .	O. J. Pennell, .	Williamsport,	"	29
Felloes,—Machines for Bending	Arthur Hemenway, .	Cleveland,	Ohio,	1

Felling Trees,	Pomeroy Johnson,	Whitney's Pt.,	N. Y.	15
Ferules,	T. W. Detray,	Montpelier,	Vt.	29
Fertilizers,	Lemuel Stephens,	Philadelphia,	Penna.	8
———,—Mach's for Sowing	R. J. Hill,	Americus,	Ga.	29
Filters,	L. S. Chichester,	City of	N. Y.	29
Filtering Apparatus,	J. H. G. D. Wagner,	Paris,	France,	29
Fire Arms,—Hammer Guards	Benjamin Singleton,	Portsmouth,	Va.	1
———,—Repeating	W. H. Elliott,	Plattsburgh,	N. Y.	29
———	"	"	"	29
———,—Revolving	Savage and North,	Cromwell,	Conn.	15
———	A. J. Gibson,	Worcester,	Mass.	22
Fire-escape,	Frederick Seymour,	Cincinnati,	Ohio,	1
———	Baker and McGill,	City of	N. Y.	22
———	Leonard King,	Bridgeport,	Conn.	22
———	Louis Knocke,	Davenport,	Iowa,	22
———	Albin Warth,	City of	N. Y.	29
———	Henry Powelson,	N. Brunswick,	N. J.	29
Fire-place,	Alfred Carson,	City of	N. Y.	22
Fire-proof,—Rendering Safes	A. K. Eaton,	Brooklyn,	"	29
Flock,—Machinery for Cutting	J. Tilton & E. Riston,	Northfield,	N. H.	15
Flues,—Construction of	R. F. O'Brien,	Boonville,	Mo.	15
Fruit and Vegetable Cutter,	W. H. Trissler,	Lima,	Ind.	22
Furnaces,	R. R. Taylor,	Reading,	Penna.	8
———,—Hot-air	Jacob Stuber,	Utica,	N. Y.	1
———,—Feeding Sawdust to	J. P. Wigal,	Henderson,	Ky.	8
Gasaliers,	J. W. Kerr,	Pittsburgh,	Penna.	22
Gas,—Apparatus for Generating	A. K. Tupper,	Milford,	Mich.	22
—— Burners,	G. W. Thompson,	City of	N. Y.	1
—— Retorts,	Charles Wooster,	"	"	22
———,—Securing Lids	J. R. Thomas,	Williamsburgh,	"	29
Gates,	S. H. Sill,	Geneva,	"	8
Gate Pulley,	David Bedell,	Seneca Falls,	"	8
Girders,—Iron Truss	J. W. Murphy,	Philadelphia,	Penna.	8
Glass,—Grinding & Polishing	Albert Broughton,	City of	N. Y.	29
Governor Valves,	G. H. Timmerman,	St. Louis,	Mo.	1
Grain Binding Machines,	Daniel W. Ayres,	Middleport,	Ill.	22
—— Cleaners,	P. C. Fritz,	Barrytown,	N. Y.	1
———	W. W. Webster,	Foxville,	Va.	1
—— Scales,	Charles Hunter,	Indianapolis,	Ind.	8
—— Separators and Cleaners,	Wm. M. Amall,	Sperryville,	Va.	1
—— Weighing Machines,	Lovett Eames,	Kalamazoo,	Mich.	15
Grate,—Coal	W. T. McMillen,	St. Louis,	Mo.	22
Grinding Surfaces,—Pig Metal	Thaddeus Selleck,	Greenwich,	Conn.	1
Grist Mills,	Charles Badger,	Edgerton,	Wis.	22
Gun Stocks,	C. R. Alsop,	Middletown,	Conn.	22
Hair,—Picking Curled	William Adamson,	Philadelphia,	Penna.	29
Halters,	Lewis Whitehead,	Nunda,	N. Y.	1
Hame Tugs,	Jacobs Hovey,	Bedford,	Mich.	8
Harrows,—Seeding	M. S. Root,	Medina,	Ohio,	22
Harvesters,	S. T. Bruce,	Marshall,	Mo.	1
———	W. A. Kirby,	Buffalo,	N. Y.	15
———	Stoler and Sisson,	Bristol,	Penna.	15
———,—Guard Fingers for	G. W. Slough,	Canton,	Ohio,	8
———,—Raking Attach. for	W. H. Wilson,	Denton,	Md.	8
Harvesting Machines,	J. A. Wagner,	Pultney,	N. Y.	22
Hat Bodies,—Felting,	M. R. Lemman,	Columbus,	Miss.	8
Heating Apparatus,—Steam	L. W. Leeds & C. Vaux,	City of	N. Y.	29
———	G. W. Richardson,	"	"	29
——— Buildings,—Boiler for	C. F. Hitchings,	"	"	15
Hemp Brakes,	John Mills, Jr.,	Quincy,	Ill.	29
Hoisting Machinery,	R. A. Wilder,	Cressona,	Penna.	1
——— Persons,—Machines for	I. H. Hobbs,	Philadelphia,	"	15

Hollow Ware,—Spin'g Metallic	John Grey,	Pittsburgh,	Penna.	1
Hominy Mills,	Heatwole & Mauck,	Harrisonburgh,	Va.,	1
Hook Catch for Doors,	C. B. Richards,	Brooklyn,	N. Y.	8
Hooks and Eyes,	D. M. Smith,	Springfield,	Vt.	22
Hoops,—Locks for Metal Bale	C. A. Dubs,	Natchez,	Miss.	8
——,—Machine for Splitting	S. F. Atherton,	Fitchburgh,	Mass.	1
Horse Powers,	Glidden & Starkweather,	Alvaretta,	Wis.	29
—— Shoes,	R. A. Goodenough,	Brooklyn,	N. Y.	29
Horses' Feet,—Cushion for	Loren Hall,	Milford,	Mass.	29
Hose,—Machines for Rubber	T. J. Mayall,	Roxbury,	"	15
——,—Manufacture of Rubber	"	"	"	22
—— Coupling,	S. W. Warren,	Brooklyn,	N. Y.	8
—— Tubing,	H. A. Alden,	Matteawan,	"	8
————,—Rubber	T. J. Mayall,	Roxbury,	Mass.	22
————,—Flexible,	H. A. Alden,	Matteawan,	N. Y.	22
Hydrants, &c.,—Valves for	M. C. Meigs,	Washington,	D. C.	22
Hydraulic Motor,	Wm. Kennish,	London,	Engl'd,	15
———— Presses,	C. W. Flippen,	Laurel Grove,	Va.	8
Ice Cream Freezers,	G. W. Davis,	New Orleans,	La.	22
————	C. W. Packer,	Philadelphia,	Penna.	22
————	G. W. Brown,	City of	N. Y.	29
—— Pitcher,	N. F. Griswold,	Meriden,	Conn.	1
India Rubber Goods,—Finishing	Trotter & Williams,	City of	N. Y.	22
Ink Reservoir for Pens,	R. B. Fitts,	Philadelphia,	Penna.	8
Iron,—Restoring Burnt	G W Morris & W Quann,	"	"	1
Kettle Ears,—Making	Morris Wells,	Brooklyn,	N. Y.	8
Keys,	James Deally,	Louisville,	Ky.	29
——,—Attaching Bows to	E. L. Gaylord,	Terrysville,	Conn.	29
Key-holes,—Guards for	T. G. Harold,	Brooklyn,	N. Y.	29
Knives,—Sharpening Cylind.	J. H. and A. T. Goodell,	City of	"	1
Knitting Machines,	Eli Tiffany,	Thompsonville,	Conn.	1
————	John Chantrell,	Bristol,	"	15
————	W. H. McNary,	Brooklyn,	N. Y.	15
Lamps,	John Stuber,	Utica,	N. Y.	1
——	Octave Saulay,	New Orleans,	La.	8
——,—Vapor,	M. V. B. Buel,	Buffalo,	N. Y.	1
————	T. G. Clayton,	Washington,	D. C.	15
————	I. W. Pettibone,	Norfolk,	Conn.	15
————	J. H. Rollins,	Wapello,	Iowa,	15
————	Albertus Geiger,	Dayton,	Ohio,	29
————	S. W. Lowe,	Philadelphia,	Penna.	29
————	T. S. Ray & A. C. Rand,	Buffalo,	N. Y.	29
————,—Burners for	Emil Trittin,	Philadelphia,	Penna.	15
————,—Generators for	S. D. Baldwin,	Milwaukie,	Wis.	8
Lanterns,	J. D. Brown,	Cincinnati,	Ohio,	29
Laps,—Machinery for Winding	J. E. Cheney,	Lowell,	Mass.	15
Lasting Machines,	W. Wells,	Boston,	"	1
Lathes,	J. M. Scribner,	Middleburgh,	N. Y.	15
Leather,—Machines for Finish'g	W. P. Martin,	Salem,	Mass.	1
——,—— Stretch'g	J. H. Haskell,	Baltimore,	Md.	15
Lifting Jacks,	Wm. Clare Anderson,	St. Louis,	Mo.	15
Locks,	Lyman Derby,	City of	N. Y.	8
Lock,	Andrew Rankin,	Philadelphia,	Penna.	22
Locks for Traveling Bags,	Bourne & Cunningham,	City of	N. Y.	1
Locomotive Boilers,	John Thompson,	East Boston,	Mass.	29
Looms,	Tillotson Clarkson,	South Adams,	"	1
——	J. H. Clifton,	Newcastle,	Penna.	29
——,—Harness Frames for	James Greenhalgh, Sr.,	Pascoag,	R. I.	15
——,—Narrow-ware	Benjamin Hardy,	City of	N. Y.	1
Lozenges,—Machines for Cut'g	W. J. McClelland,	"	"	8
——,—— Mak'g	Gottfried Kober,	"	"	22

Mainsails of fore-and-aft vessels,	G. W. Gerau, .	Brooklyn,	N. Y.	22
Marine Charts,—Bearings, &c.,	E. R. Knorr, .	Washington,	D. C.	1
——— Propeller, .	Eldridge Weber, .	Gardiner,	Maine,	29
Measuring Tapes,	O. W. Minard, .	Waterbury,	Conn.	1
Meat Chopper, .	C. B. Beeker, .	Lancaster Co.,	Penna.	8
—— Cutter, .	Purches Miles, .	New Haven,	Conn.	22
Mechanical Movements, .	J. H. Wait, .	Portsmouth,	Ohio,	15
Millstones,—Cementing	Samuel Hoyt, .	Wilmington,	Del.	1
————,—Dress for .	John Broughton, .	City of	N. Y.	22
————,—Hanging	J. H. Glover, .	Glasgow,	Ky.	22
———————— .	G. P. Dance. .	Columbia,	Texas,	29
Mills,—Plates to .	Stephen Hull, .	Poughkeepsie,	N. Y.	22
Mill Races,—Floating Sluices	M. A. Shepard, .	Parkersburgh,	Ill.	8
Moulding, .	John Dougherty,	Cold Spring,	N. Y.	15
Mouldings,—Machine for Cut'g	J. B. Winslow, .	Charlestown,	Mass.	29
Mop Wringer, .	Orville Choate, .	Morrisville,	Vt.	15
Motion,—Converting .	Louis Planer, .	City of	N. Y.	22
Mousing Hook, .	S. G. Coleman, .	Providence,	R. I.	1
Mowing Machines, .	A. M. George, .	Nashua,	N. H.	1
Mowing and Reaping Machines,	Richard Ketchum,	S. Dansville,	N. Y.	15
Musical Instrument, .	Aloys White, .	New Haven,	Conn.	8
———— Instruments,—Reed	George Woods, .	Boston,	Mass.	8
———— Reeds, .	J. C. Briggs, .	Woodbury,	Conn.	1
Nut Cracker, .	S. J. Smith, .	City of	N. Y.	15
Oils obtained from Coal,	Luther Atwood, .	City of	N. Y.	29
——,—Condensing Coal	J. F. Bennett, .	Pittsburgh,	Penna.	29
——,—Distilling Coal .	H. W. Adams, .	Brooklyn,	N. Y.	29
——,—Re-distillation of Coal	Luther Atwood, .	City of	"	15
——, &c.,—Furnace for Coal	James Calkin and others,	Hudson,	"	8
Ordnance,—Breech-loading	Wm. W. Hubbell, .	Philadelphia,	Penna.	29
————————	" .	"	"	1
Ores,—Machines for Crushing	Wm. P. Parrott, .	Boston,	Mass.	1
Ovens, .	Duncan McKensie,	Brooklyn,	N. Y.	1
Ox Shoes, .	A. Van Valkenburgh,	Griffin's Corners,	"	8
— Yoke Fastenings, .	Wm. N. Lockwood,	New Britain,	Conn.	22
Paint,—Machines for Mixing	Brown & Banker, .	Boston,	Mass.	15
Paper,—Preparation of .	J. L. Jullion, .	Aberdeen,	Gr. Brit.	8
——— Bag Machine, .	S. E. Pettee, .	Philadelphia,	Penna.	29
——————— .	G. F. Lufbery, .	City of	N. Y.	8
——— File, .	Elisha Clark. .	"	"	8
———— .	Adolphus Liebenroth,	"	"	22
———,—Safety .	M. A. Howell, Jr., .	Ottawa,	Ill.	22
——— Stuff,—Boilers for	C. S. Buchanan,	Ballston Spa,	N. Y.	1
Peach Parer, .	Marvin Smith, .	New Haven,	Conn.	15
Pegging-machine Jack, .	Walter Fitzgerald,	Boston,	Mass.	22
Pessaries, .	J. M. Heard, .	Aberdeen,	Miss.	29
Piano-fortes, .	J. A. Gray, .	Albany,	N. Y.	1
Piano-forte Action,	Wm. Compton, .	City of	"	22
——————— .	G. H. Hulskamp,	Troy,	"	22
Pictures,—Mouldings for Hang'g	Henry Hochstrasser, .	Philadelphia,	Penna.	8
Pile Fabrics,—Manufacture of	Noble Hill, .	Caton,	N. Y.	29
Pipes,—Molds for Cement	Henry Knight, .	Jersey City,	N. J.	8
———,—Moulding Iron .	Wm. Doyle, .	Albany,	N. Y.	15
Pipe,—Making Sheet Metal	C. T. Boardman, .	Bergen Point,	N. J.	8
—— Wrench, .	Wm. F. Beecher,	Chicago,	Ill.	1
Ploughs, .	J. H. Gooch, .	Oxford,	N. C.	8
———— .	J. S. Willson, .	Waynesboro',	Ga.	8
———— .	Wm. C. Pitts, .	Austin,	Texas,	15
———— .	Wood & Byrington,	Byron,	Ill.	15
———— .	J. S. Huggins, .	Timmonsville,	S. C.	22
———— .	I. N. Rankin, .	Middletown,	Iowa,	22

Ploughs,	Rhodes & Skaggs,	Talladega,	Ala.	22
————	C. L. Shiver,	Camden,	S. C.	22
————,—Clevis for	Calvin Adams,	Pittsburgh,	Penna.	22
————,—Cultivating	Allen Hughes,	Gratiot,	Ohio,	29
————,—Mold-boards for	H. H. Scoville,	Syracuse,	N. Y.	29
————,—Spade	Elijah Harris,	Princeton,	Ill.	22
Plough Stocks,	J. A. Boyd,	Jackson Co.,	Fla.	1
Pointers,—Perforating Rule for	Wm. H. Harding,	Philadelphia,	Penna.	1
Post Butt,	James Holland,	Conshohocken,	"	15
Potato Diggers,	John Bawden,	Freehold,	N. J.	8
————	Elijah Robertson,	Hartford,	Conn.	8
————	David Niven,	Rochester,	N. Y.	15
————	Carolus Dunham,	Batavia,	"	22
Powder Flasks,	G. W. Whipple,	West Acton,	Mass.	1
Preserve Cans,	Theodore Sellers,	E. Birmingham,	Penna.	22
————	Wm. H. Harn,	Carlisle,	"	22
————	A. T. Twing and others,	Lansingburgh,	N. Y.	22
Printers Composing Stick,	S. W. Brown,	Syracuse,	"	22
Printers,—Roller Boxes for	H. J. Spiller,	Cincinnati,	Ohio,	29
Printers Rule,—Tool for Miter'g	Grover & Pelouse,	Middletown,	N. Y.	29
Printing Addresses on Papers,	Noah Bowles,	"	Md.	1
Prisons,—Window Grating for	Edwin May,	Indianapolis,	Ind.	29
Presses,—Power	Charles Oyston,	Little Falls,	N. Y.	22
————	James Weed,	Muscatine,	Iowa,	22
Propellers,—Applying Steam to	A. M. Sawyer,	Athol,	Mass.	8
Prunes,—Curing	Isaac Reckhow,	Brooklyn,	N. Y.	22
Pumps,	George Lindsay,	Petersburgh,	Va.	1
———	J. E. Atwood,	Bucksport,	Maine,	8
———	Walter Peck,	Rockford,	Ill.	8
———	Washburn Race,	Seneca Falls,	N. Y.	22
———	J. M. Stephenson,	Anderson,	Ind.	22
———	G. H. Mills,	East Boston,	Mass.	22
Quartz,—Machinery for Crush'g	J. C. Dickey,	Saratoga Sp'gs,	N. Y.	8
Raft,—Life-saving	S. B. Broad,	City of	N. Y.	8
Railroads,—Rails for Street	George Eaton,	Boston,	Mass.	1
Railroad Cars,—City	W. C. Allison,	Philadelphia,	Penna.	29
————,—Journals for	Humphrey Jackman,	Elizabethport,	N. J.	1
————,—Propelling	Busser & Harmer,	Philadelphia,	Penna.	8
————,—Ventilator for	Asa Hapgood,	Worcester,	Mass.	22
——— Chairs,	I. W. Wetmore,	Erie,	Penna.	15
——— Jacks,	F. H. Furniss,	Cleveland,	Ohio,	15
Ranges,—Cooking	F. S. Merritt,	City of	N. Y.	1
———, &c.,—Water-backs for	W. S. Mayo,	"	"	1
Ratan Machine,	Liveras Hull,	Charlestown,	Mass.	29
Reels,—Silk or Thread	S. W. and J. F. Palmer,	Auburn,	N. Y.	15
Rice Hullers,	I. M. Hendricks,	Philadelphia,	Penna.	29
—— and Clover Hullers,	Stephen Burrows,	Whitewater,	Wis.	8
Rifle Canes,	Andrew Crow,	Middlefield,	Mass.	8
Rocking Chair,	H. J. Coster,	Chicago,	Ill.	8
———— into a Cradle,	R. H. Ewing,	Nicollet Co.,	Minn.	8
Rotary Engines,	A. F. Reeder,	Bloomington,	Ill.	15
Ruffles,—Manufacture of	G. B. Arnold,	City of	N. Y.	8
Saccharine Juices,—Evaporat'g	L. P. Harris,	Mansfield,	Ohio,	29
————————	A. C. Clemens,	Crain township,	"	22
Salt,—Manufacture of Common	Thomas Spencer,	Syracuse,	N. Y.	29
Sash-fastener,	J. M. Whitney,	Astoria,	"	15
————	Ross Johnson,	Baltimore,	Md.	29
Sausage Filler,	Amos Shepard,	Southington,	Conn.	22
——— Machine,	J. G. Perry,	S. Kingston,	R. I.	15
Saw-set,	A. L. Currier,	Washington,	D. C.	15
Saw Teeth,—Machine for Cut'g	Frederick Shuttee,	Philadelphia,	Penna.	29

Saws,—Machine for Filing	Patrick McMahon,	Scottsville,	N. Y.	1
——,—Hanging Reciprocating	Charles Weston,	Salem,	Mass.	8
Screw Plates,	Z. L. Jacobs,	Hebron,	Conn.	15
Seeding Machines,	W. J. Baker,	Dimock,	Penna.	8
——————	A. E. Doty,	N. Henderson,	Ill.	22
——————	David Eldred,	Monmouth,	"	22
——————	A. Kirlin,	New Boston,	"	22
——————	S. T. Holly,	Rockford,	"	29
——————	J. R. Turner,	Jacksonville,	"	8
Seed Planters,	W. C. Pitts,	Austin,	Texas,	15
————	Ephraim Russell,	Coatsville,	Penna.	15
————	J. W. Masten,	Utica,	Mich.	22
Sewing Machines,	J. S. McCurdy,	Brooklyn,	N. Y.	1
——————	G. B. Arnold,	City of	"	8
——————	Birdsill Holly,	Lockport,	"	8
——————	E. E. Bean,	Boston,	Mass.	8
——————	George Little,	City of	N. Y.	15
——————	Samuel Hoffman,	Richmond,	Va.	22
——————	J. N. Chamberlin,	Troy,	N. Y.	29
——————	Hamilton Ruddick,	Boston,	Mass.	29
Shaving Cup,	T. E. Hughes,	Birmingham,	Penna.	1
Shears,—Rotary Cutting	C. W. Brown,	Boston,	Mass.	22
Sheathing Felt,—Manufacturing	J. B. Hyde,	Newark,	N. J.	29
Shingle Machines,—Feed'g Bolt	N. S. Gilbert,	Albion,	N. Y.	8
Shoe Plate,	T. W. Porter,	Bangor,	Maine,	8
Shoemakers Float,	F. L. Langley,	Troy,	N. Y.	15
Shot and Shells,—Moulding	David Huestis,	Cold Spring,	"	15
Shovels,—Manufacture of	S. D. Nelson,	Pittsburgh,	Penna.	15
Shovel and Tongs,—Combinat.	J. W. Evans,	Forsyth,	Ga.	15
Shutters,—Metallic Rolling	J. B. and W. W. Cornell,	City of	N. Y.	15
Signal Apparatus,	T. T. Woodward,	S. Reading,	Mass.	15
Silicates,—Preparation of	G. E. Vanderburgh,	Mamoraneck,	N. Y.	29
Skates,	John Lovatt,	Newark,	N. J.	29
———	Wm. Scarlett,	Aurora,	Ill.	29
———,—Wheel	Reuben Shaler,	Madison,	Conn.	29
Sliver Machines,	F. T. Grant,	Gardiner,	Maine,	29
Smut Machines,	G. B. Turner,	Cuyahoga,	Ohio,	1
Snow or Ice into Large Blocks,	Harris Morse,	Columbia,	Cal.	15
Soil,—Breaking and Pulverizing	R. J. Gatling,	Indianapolis,	Ind.	29
Spinning Yarn,—Machinery for	J. E. Crowell,	Chelsea,	Mass.	8
————————————	Edmund Victory,	Watertown,	"	8
Spirit Levels,	W. T. Nicholson,	Providence,	R. I.	1
Spring Balances,—Compensat'g	O. S. Squyer,	West Dresden,	N. Y.	8
Starch,—Machinery for Clean'g	C. S. Irwin,	Madison,	Ind.	15
Steam Boiler Feeders,	Sanderson & Stanton,	Syracuse,	N. Y.	15
———— Furnaces,	D. H. Williams,	Alleghany,	Penna.	15
———— Regulator,	C. A. Wilson,	Cincinnati,	Ohio,	1
——— Boilers,—Alarm Valves	Selah Dustin,	Detroit,	Mich.	8
————,—Safety Valve,	W. Mt. Storm,	City of	N. Y.	1
————,—Sediment Col.	J. T. Price,	Rockville,	Ind.	15
————,—Therm. Cases	G. E. Hayes,	Buffalo,	N. Y.	8
——— Engines,	John Randall,	Elmira,	"	8
—————,—Air Pumps	D. A. Woodbury,	Rochester,	"	8
—————,—Slide Valves	Andrew Buchanan,	Jersey City,	N. J.	15
—————,—Governors	G. W. Rains,	Newburgh,	N. Y.	29
—————,—Gov. Valves	Wm. Chambers,	Muscatine,	Iowa,	1
——— Traction Engines,	J. F. Holloway,	Saline Mines,	Ill.	29
——— Gauges,	E. G. Allen,	Boston,	Mass.	1
——— Generators,—Coal Oil in	Thomas Shaw,	Philadelphia,	Penna.	29
Stills,—Construct. Condensers of	Patrick Mihan,	Boston,	Mass.	15
Straw Cutters,	N. Edwards & E. G. Day,	Chittenden Co.,	Vt.	1
Stoves,	Samuel Shadbolt,	Scottsville,	N. Y.	8
———	J. C. Henderson,	Albany,	"	29

Stoves, .	J. G. Treadwell, .	Albany,	N. Y.	15
———,—Cooking .	J. C. Henderson,	"	"	1
Stove Grates, .	Edward Mingay, .	Boston,	Mass.	1
Sugar,—Machine for Drying	A. W. J. Mason,	New Orleans,	La.	8
———,—Appa's for Cut'g Loaf	Kinzler & Rosebrock,	City of	N. Y.	8
——— Juices,—Evaporating	Charles Harvey, .	Richmond,	Ind.	8
Swift, .	C. P. S. Wardwell,	Lake Village,	N. H.	15
Syringes,—Enema	F. B. & B. L. Richardson,	Boston,	Mass.	8
Table Fork, .	Wm. Mannheimer, .	City of	N. Y.	1
Telegraphic Machines,	Jedediah Weiss,	Bethlehem,	Penna.	15
——— Instruments,	A. G. Holcomb, .	City of	N. Y.	15
Threshing Machines, .	D. S. Wagner, .	Penn Yan,	"	1
Tire,—Cooling and Setting	Permin Kopfer, .	Fond du Lac,	Wis.	29
———,—Shortening .	Abraham Voorhees,	Grand Rapids,	Mich.	22
———,—Shrinking	S. S. Greene, .	Rome,	N. Y.	29
Tobacco Presses, .	T. N. Read, .	Aspen Wall,	Va.	22
Toy Cannons, .	J. O. Couch, .	Middlefield,	Conn.	1
Troughs,—Making Rain,	Wm. H. Henderson,	Franklin,	Ind.	22
Trunk Lock, .	S. Bourne, Jr., .	City of	N. Y.	1
Tube Joints,—Making .	S. I. Hayes, .	Chicago,	Ill.	29
Tweer, .	Alanson Ordway, .	Stratham,	N. H.	15
Type,—Machine for Setting	C. W. Felt, .	Salem,	Mass.	29
Valve Cocks, .	Nickerson & Colton, .	Athens,	Ga.	8
Vapor Burners, .	Wm. N. Brown,	Camden,	N. J.	15
Vegetable Slicer, .	S. T. Sanford, .	Fall River,	Mass.	22
Veneers,—Mosaic	Heinigke and Laemmel,	Bay Ridge,	N. Y.	29
Vise, .	T. B. Lamb, .	Summit,	Mich.	22
Voltaic Gas Batteries,	Maurice Vergnes,	City of	N. Y.	15
Wagon Shaft Shackle, .	J. B. Thorp, .	Plantsville,	Conn.	1
Walls,—Construc. of Concrete	S. T. Fowler, .	Brooklyn,	N. Y.	1
Washing Machine, .	Ingraham & Rounds,	Berlin,	Wis.	8
———	E. D. Thomas, .	Rochester,	N. Y.	8
——— .	J. S. Pond, .	Cleveland,	Ohio,	15
———	" .	"	"	22
——— .	Mark Richardson, .	Philadelphia,	Penna.	22
———	Clark Roberts, .	Winchester,	Ill.	22
——— .	A. Leightheiser, .	Reading,	Penna.	29
———	S. W. Woodward,	Buffalo,	N. Y.	29
Water Elevator, .	Maximilian Wappich,	Sacramento,	Cal.	29
——— from Wells,—Elevating	Billings & Hutton,	Cleveland,	Ohio,	22
——— Heating Appa's—Valve	J. E. Boyle, .	Brooklyn,	N. Y.	1
——— Wheels, .	G. H. Jones & J. Brown,	Rose,	"	1
——— .	Lyman Gibson, .	Elmira,	"	1
——— .	A. M. Swain, .	Lowell,	Mass.	15
Window Sashes,—Hanging	Thomas Fry, .	Brooklyn,	N. Y.	15
Windlasses, .	S. D. Avery, .	Norwich,	"	8
Wind-mills, .	E. W. Mills, .	Amber,	"	1
——— .	W. J. Tustin, .	Benicia,	Cal.	22
Wood,—Machines for Bundling	W. L. Williams, .	City of	N. Y.	8
———,—Preparing & Moulding	Philander Shaw,	Boston,	Mass.	15
Wool,—Removal of Burrs from	C. L. Harding, .	Winooski Falls,	Vt.	29
Wrench, .	G. B. Phillips, .	Newark,	N. J.	15
Wrenches,—Rolling Shanks of	L. and A. G. Coes, .	Worcester,	Mass.	8
Wringing Clothes,	J. H. Clark, .	Westbrook,	Maine,	8
Writing Desk, .	Elisha Hughes, .	McCartysville,	Cal.	1
Yards to Topmasts,—Attachm't	Samuel Hall, .	Boston,	Mass.	22
———,—Hanging Topsail	James Nute, .	East Boston,	"	22

EXTENSIONS.

Sugar Pans, .	Alfred Stillman, .	City of	N. Y.	22
Wood Screws,—Manufacturing	T. W. Harvey, .	"	"	29

ADDITIONAL IMPROVEMENTS.

Fire Arms,—Revolving .	E. D. Newbury, .	Albany,	N. Y.	1
Protractor, .	Josiah Lyman, .	Lenox,	Mass.	15
Tenons on Spokes,—Cutting	Mahlon Gregg, .	Philadelphia,	Penna.	15
Washing Machine,	Charity Pendleton,	Galena,	Ill.	29

RE-ISSUES.

Bells,—Hanging .	G. W. Hildreth, .	Lockport,	N. Y.	1
Bonnet Frames, .	W. E. Kidd, .	City of	"	15
Burglars Alarms, .	Wilson & Thomas, .	Frankfort,	"	22
Corn Huskers, .	D. M. Mefford, .	Jeffersonville,	Ind.	15
Curtain Fixtures, .	Lewis White, .	Hartford,	Conn.	22
Gas,—Heating or Cooking by	W. F. Shaw, .	Boston,	Mass.	29
Harvesters, .	C. B. Brinckerhoff, .	Batavia,	N. Y.	22
———,—Grain and Grass	C. Aultman & Co.,	Canton,	Ohio,	1
———————	" .	"	"	1
Iron Pavement,—Cellular	Titus & Des Granges,	St. Louis,	Mo.	1
Kettles,—Grinding Cast Iron	C. C. Bradley, Jr., .	Syracuse,	N. Y.	1
Knitting Machines, .	Tompkins & Johnson,	Troy,	"	15
Ranges,—Cooking	H. H. Stimpson, .	Boston,	Mass.	1
Steam Boilers,—Prev. Incrust. of	H. F. & L. F. Knoderer,	Chillicothe,	Ohio,	15
Stoves,—Coal .	C. Eddy & J. Shavor,	Troy,	N. Y.	8
Sugar,—Machine for Cut'g Loaf	A. & F. Brown, .	City of	"	1
Sugar Mould Carriages,	C. E. Bertrand, .	Williamsburgh,	"	29
Water-proof Leather Goods,	Samuel La Forge, .	Cleveland,	Ohio,	15
Wheel Hubs,—Casting Boxes	Thomas Ellis and others,	Philadelphia,	Penna.	1

DESIGNS.

Spoon and Fork Handles,	M. Gibney, .	City of	N. Y.	15
Stove, .	J. Greer & R. I. King,	Dayton,	Ohio,	15
—— Plates, .	Hubbell & Wood, .	Buffalo,	N. Y.	15
Stoves, .	Jacob Resor, .	Cincinnati,	Ohio,	15
Stove Plate, .	J. Siddons & J. C. Hart,	Rochester,	N. Y.	15
Stoves,—Parlor .	Wm. W. Stevens,	Portland,	Maine,	15

FRANKLIN INSTITUTE.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"A method of Lighting Gas by the Electric Spark invented by Mr. Arch. Wilson, of the City of New York,"

Report:—That the apparatus proposed by Mr. Wilson for this purpose, consists, first, in an insulator applied to every burner which is to be lighted, so as to cut off all electric communication between the burner and the gas-pipe; secondly, in the establishment of proper electric conductors between the burners thus insulated; and thirdly, in bringing the ends of the conducting wire into communication with the poles of one of Ritchie's Induction Apparatus, by means of which a spark may be caused to pass at each break in the circuit.

First; the insulator consists at present of a piece of hard india-rubber screwed on to the top of the gas-pipe, into the upper end of which the burner in its turn is screwed. Over this insulator is slipped a loop of copper wire, one end of which is turned upwards and bent so as to present its end immediately over the opening of the burner; the loop

is also connected with a copper wire which passes to the next preceding burner. It will be seen that when this arrangement is completed, if an electric current be passed over the wire sufficiently powerful to overcome the resistances at the breaks, a spark will pass from the end of each wire, through the air above the opening, to the burner, and from the first burner will pass to the next, and so in succession generating a spark at each opening of the circuit. But to effect this, very considerable tension will be required in the current.

Secondly; the wires are arranged in such order, passing from the Ritchie to the wire above the first burner; then from this burner to the wire above the second, &c.; that (including the spark passage across the air from the wires to burners) there is a single electric communication made by bringing the first and last wires into communication with the poles of the Ritchie coil; and thus the conditions of the last paragraph are fulfilled, provided the coil be sufficiently powerful.

Thirdly; Ritchie's Induction Apparatus (or, as the maker calls it, Ritchie's Rhumkorff's Induction Apparatus) is an apparatus in which, by very ingenious arrangements which this is not the proper place to describe, a very long and powerful spark is obtained from the secondary or induction current from a battery which may be of few cups and of small dimensions. The apparatus with which Mr. Wilson experimented before the Institute, is capable of giving a spark of 11 inches in length in the air. And as the resistance to the passage of the spark seems to be in the inverse ratio of the square of the distance; this power ought to be able to pass across more than seven thousand openings of $\frac{1}{8}$-inch each.

After thus briefly explaining the mode of lighting proposed by Mr. Wilson, and referring those particularly interested to the more full explanations given by Mr. W. in his remarks before the Institute at the meeting in March (see *Jour. Frank. Inst.*, vol. xxxix, p. 385), let us inquire into its novelty and its probable utility. Any student of electric science or practice will have at once suggested to his mind two modes in which this force may be used to ignite a current of gas at a distance: the first, by means of the heating power of the current while passing through an insufficient metallic conductor; under which circumstances the conductor becomes red, or even white hot; the other by means of the spark, which is in effect a small portion of matter intensely heated for a single moment. Now in order to meet the exigencies of practice, the mode of lighting, as Mr. Wilson very properly remarks, must be "simple, easy to adjust, efficient, reliable, and economical." Let us inquire how far these properties are possessed by each of the suggested modes.

And first as to the efficiency. The mode of lighting, by heating portions of a continuous conductor, depends upon the creation of a resistance to the passage of the current, by which resistance the heat is developed. In proportion, then, as you increase the number of your resistances you must increase the power of your battery—and as each retardation diminishes the amount of the current; if it happen that the second, or any succeeding wire is more capable of passing the cur-

rent than the first, this wire will not heat. When, then, an attempt is made to ignite a number of gas-jets by fine platinum wires stretched above them, and communicating by means of a larger conductor, care must be taken that the first be not either finer or longer than any of the others, otherwise those which are coarser or shorter than the first will not produce their effect. Again, great care must be taken to insure an equality in the quantity of the current passed; for when the wires have been adjusted to a certain quantity, a less quantity will not heat them; a greater quantity will be liable to fuse them. Again, care must be taken that the wires are stretched immediately over the opening of the burners; a slight variation to the right or left will entirely prevent the lighting. When all these precautions are taken, a strong breeze of air, or even perhaps the current of gas issuing under a heavy pressure will cool the wires too rapidly to prevent the lighting. And it must be remembered that a low red heat is not sufficient to ignite a mixture of lighting-gas and air.

In reference to reliability; the wires are apt to fuse and thus break the connexion; to expand irregularly by the heat and thus be bent away from the opening of the burner; to incrust with soot, or dust, or damp, and thus prevent their ignition. They are simple but not easy to adjust or to keep in adjustment; and as to economy, require a much larger battery, and therefore more consumption of zinc and acid than the present plan.

But, in fact, from the operation of the causes we have pointed out under the heads of efficiency and reliability, this mode has always failed in practice, and we are obliged to have recourse to the spark, if we can succeed at all.

The great objection which has hitherto prevented the spark from being practically applicable to lighting gas, has been the difficulty of procuring and confining a current of sufficient intensity to overcome any great number of interruptions, and thus to produce the required number of sparks. The galvanic battery was not available, for the spark produced directly, is small and feeble; the electric machine is fragile, uncertain, difficult to keep in order, dependent on the weather, and laborious to work with. So that although propositions to light by spark are quite numerous both in England and France, yet in practice the method had never succeeded on trial, especially in a permanent manner.

Now the only practical method known to us of obtaining surely, efficiently, and easily, sparks sufficient for this purpose, is by the Induction coil, and we do not think we advance too far when we say by Ritchie's modification of this instrument; by which a spark of 11 or 15 inches can be produced, while heretofore they have never exceeded 3 inches.

The experiments made before the Committee and before the Institute by Mr. Wilson, as well as those which have been in operation for a year in New York on a practical scale, appear to demonstrate that this mode of lighting is efficient inasmuch as it is able to light many hundred burners at any distance within the limits of our largest rooms,

and probably even in our streets; that it is reliable, inasmuch as it is not liable to get out of order, or to deteriorate (provided the wires from which the sparks are taken are made of platina or some other refracting metal); that it is easy to adjust, requires no re-adjustment, unless by accident, when the damaged locality is easily detected and easily repaired; that it is simple, requiring no knowledge for its management, except for the filling the cells of the battery (which need not exceed three cups) with the acid, an operation probably not required more than once a month if the apparatus is used several times every night; and it is economical, both because of the small quantities of material consumed by the small battery required, and from the instantaneous action, saving a large quantity of gas which is now suffered to run to waste while the burners are lighted successively. The spark can also be repeated indefinitely and rapidly so as to light on a second or subsequent trial any burners which may have escaped the first attempt.

For these reasons, and on account of the experiments made in their presence, as well as of those tried elsewhere, the Committee report that in their opinion there is every reason to believe that Mr. Wilson's Electric Gas-lighter will be successful in practice; and that it is well worthy of trial on a large scale.

By order of the Committee,

WM. HAMILTON, *Actuary.*

Philadelphia, June 14th, 1860.

BIBLIOGRAPHICAL NOTICE.

Elements of Chemical Physics. By JOSIAH P. COOK, Jr., Erving Professor of Chemistry and Mineralogy in Harvard University. Boston: Little, Brown & Co., 1860, 8vo.

This work is intended especially to furnish to the student of chemistry a knowledge of such of the theories and facts in physics as are likely to be of importance to him in the pursuit of his investigations; and is designed to be the first volume of an extended work on the philosophy of chemistry. Of course, the work can hardly be fairly judged of until it is complete. The volume before us has the merit of being well brought up to the present state of knowledge upon the subject, but contains only the treatise on general properties of matter and that on heat, both of which are limited in accordance with the avowed purpose of the author. We fear, therefore, that if the work be completed on the same scale, it will be of unwieldy bulk, and scarcely so well adapted to the purposes of the chemist as the more terse work of Peschel, and others of his class. As a text-book of physics it can hardly be made available in any course of instruction fitted to the demands of the present day owing to the want of all mathematical treatment of the subjects. The definitions, too, are not so precise as they ought to be in Science, and an apparent haste of writing has sometimes led the author into errors of statement, which in a future edition should

be carefully corrected: thus, for instance, on page 57, he affirms the centre of gravity of the earth to be a *variable* point *near* the centre of the globe. The work, however, is one of good promise, admirably printed and illustrated, (though it would have been better to have changed the French legends of the wood-cuts,) and the appendix contains a very valuable set of tables; one of which is a table of logarithms, which, if we understand the preface aright, has been calculated by Capt. Chas. Henry Davis. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

JUNE.—The month commenced with indications of a coming storm. The barometric column began to fall on the 2d, and continued to fall until the afternoon of the 5th, when it reached the minimum for the month, reading at 2 P. M. of that day 29·243 inches. It then rose, slowly but regularly, until the 14th, when it again began to fall. This second wave reached its minimum on the 20th; after which it rose rapidly until the morning of the 25th, when it reached 30·123, the maximum for the month, and again gradually declined until the close. The newspapers soon brought the information of a very destructive tornado, commencing about Cedar Rapids in Iowa, on the evening of Sunday, the 3d of the month. It is described as dividing at Cedar Rapids into two winds, which passed very rapidly in curved lines to Camanche, where they united and crossed the river into Illinois, striking Albany and passing on to Amboy. The distance traversed was about 150 miles, which it accomplished in about two hours. Upwards of 200 lives were lost, and the destruction of property was very great.

On the evening of the same day a few drops of rain fell at Philadelphia; but on the next day, about 7 P. M., a heavy rain storm commenced, accompanied with thunder and lightning, and continued with but few intermissions until the morning of the 6th. During this period of two days and a half, about 2¼ inches of rain fell.

A heavy gale is also mentioned as having occurred in North Carolina on the morning of the 5th.

It is impossible with the limited information which we possess to determine whether or not these were all parts of the same storm.

On the morning of the 8th, a hail-storm continuing about fifteen minutes, passed over the northern part of the city; in the vicinity of Germantown and Manayunk a heavy rain fell at the same time, while in the southern part of the city there were but a few drops.

During the second depression of the barometer, from the 16th to the 19th of the month, we had several thunder-showers at Philadelphia; and we have accounts of a severe hail-storm and tornado in Lancaster County, Pa., on the 19th. Much damage was done to property by the wind, and the hail completely destroyed the crops along

its route. The average width of the storm did not exceed three-quarters of a mile.

The mean temperature of the month was about one degree higher than that of June of last year, but was nearly two degrees below the average of the month for the last nine years. The coldest day was the 21st, the average temperature being 60°. The thermometer was lowest on the morning of the 12th, when it indicated 52°. The thermometer was highest on the afternoon of the 29th, marking 93°; but the 30th was the warmest day of the month, its average temperature being 85·3.

Rain fell on ten days of the month, which is very near the average number for June. The amount of rain which fell during the month was 3·706 inches, which is an inch and a half less than that which fell in June of last year, but not more than half an inch below the average for June for nine years.

There was but one day of the month entirely clear, and two days on which the sky was completely covered with clouds at the hours of observation.

The force of vapor and relative humidity were both considerably below the average for the month, as may be seen by an inspection of the following table of comparisons.

A Comparison of some of the Meteorological Phenomena of June, 1860, *with those of June,* 1859, *and of the same month for nine years, at Philadelphia.*

	June, 1860.	June, 1859.	June, 9 years.
Thermometer.—Highest,	93°	96°	98°
" Lowest,	52	42	42
" Daily oscillation,	18·90	18·90	16·00
" Mean daily range,	4·20	6·10	4·60
" Means at 7 A. M.,	67·70	67·05	69·25
" " 2 P. M.,	78·38	76·76	79·29
" " 9 P. M.,	69·05	68·74	72·07
" " for the month,	71·71	70·85	73·54
Barometer.—Highest,	30·123 in.	30·152 in.	30·281 in.
" Lowest,	29·243	29·520	29·182
" Mean daily range,	·088	·116	·096
" Means at 7 A. M.,	29·757	29·881	29·825
" " 2 P. M.,	29·719	29·842	29·791
" " 9 P. M.,	29·745	29·859	29 803
" " for the month,	29·740	29·861	29·806
Force of Vapor—Means at 7 A. M.	·467 in.	·501 in.	·527 in.
" " " 2 P. M.	·464	·541	·550
" " " 9 P. M.	·480	·512	·563
Relative Humidity at 7 A. M.	68 per ct.	72 per ct.	73 per ct.
" " 2 P. M.	48	57	55
" " 9 P. M.	67	72	70
Rain, amount in inches,	3·706	5·229	4·360
Number of days on which rain fell,	10	12	11
Prevailing winds,	N.67°23′W·236	S.71°2′ W.·393	S.75°40′ W·256

Abstract of Meteorological Observations for May, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.			FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom.	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermometer.		Prevail'g winds.	Thermometer.		Prevailing winds.
May.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.		Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·849	·076	47·7	6	6·8	·296	85	0·850	E N E.	29·346	49·0	3·7	·256	61	} 0·840	E.	45·7	21·0	(var.)	48·3	17·0	N W.
2	29·742	·107	53·0	12	5·3	·333	80	0·835	N E.	29·821	54·3	5·3	·296	52		E.	52·3	11·3	N.	53·0	9·7	(var.)
3	29·793	·052	55·3	11	3·7	·224	43	0·070	N N E.	29·346	60·7	6·3	·276	39		(var.)	62·3	10·0	N.	60·7	7·7	W.
4	29·773	·029	64·3	27	9·0	·325	39		N N W.	29·303	63·0	3·0	·345	42		(var.)	65·3	3·7	N W.	66·0	5·3	?
○ 5	29·796	·034	67·8	26	3·5	·328	34		(var.)	29·300	68·7	5·7	·382	37		E.	65·3	3·3	N W.	67·7	3·7	W.
6	29·791	·037	71·3	31	3·8	·433	38		S S W.	29·273	72·7	4·0	·411	36		E.	68·7	3·3	(var.)	70·7	4·3	S W.
7	29·728	·063	74·0	28	4 7	·548	40	0·475	(var.)	29·257	77·0	4·3	·850	68		(var.)	74·0	5·3	W.	74·7	4·0	S W.
8	29·859	·132	59·5	15	14·5	·445	77		N E.	29·320	73·0	4·7	·508	58		(var.)	73·7	1·0	(var.)	71·7	3·7	?
9	29·845	·034	62·5	19	3·7	·465	61	0·042	N E.	29·250	64·0	9·0	·465	79	1·365	(var.)	70.7	3·3	N E.			(var.)
10	29·901	·056	61·7	6	4·5	·468	78	0·040	E S E.	29·205	67·3	5·3	·559	71	1·315	E.	63·0	7·7	E.	55·3		(var.)
11	29·973	·072	63·8	11	2·2	·470	71		S E.	29·246	63·3	4·0	·502	79	0·575	E.	64·0	3·7	E.	62·3	7·0	E.
☾ 12	30·018	·070	61·7	8	2·2	·516	91	0·240	S E.	29·286	62·7	0·7	.502	79	0·410	E.	63·3	4·0	S E.	59·0	4·7	E.
13	29·892	·126	67 2	22	6·5	·480	51	0·047	(var.)	29·219	62·0	1·0	·433	72	0·140	E.	63·7	5·7	S S E.			?
14	29·721	·170	64·8	13	4·0	·507	74	0·046	(var.)	29·097	66·3	4·0	·510	63		E.	63·7	8·3	S E.	65·0		N E.
15	29·864	·143	59·2	14	5·7	·282	44		(var.)	29·249	64·3	2·0	·350	46		N W.	68 7	5·0	E.	67·3	4·3	E.
16	29·837	·029	64·7	16	5·5	·270	28		S W.	29·214	67·3	3·0	·462	55		W.	67·7	1·0	N E.	63·7	3·7	N E.
17	29 992	·156	60.7	14	4·7	·376	55		E.	29·329	59·7	7·7	·356	62	0·065	(var.)	68·7	2·3	E.	67·0	4·3	N E.
18	29·847	·145	65·5	19	4·8	·517	63	0·044	(var.)	29·137	58·7	1·0	·491	88	0·417	E.	63·3	6·0	(var.)	62·3	5·7	S W.
19	29·522	·325	67·7	13	3 8	·332	40	0·017	S W.	28·824	62·7	4·0	·407	64	0·137	E.	59·0	5·7	(var.)	56·7	9·7	W.
● 20	29·679	·157	66·2	18	1·5	·353	45		W.	29·004	63·7	2·3	·206	28		(var.)	59·3	3·7	N W.	57·0	2·3	(var.)
21	29·770	·100	58·3	17	7·8	·353	50		N E.	29·041	60·3	3·3	·438	68	0·470	(var)	70·7	11·3	S W.	69·0	12·3	W.
22	29·764	·050	63·2	24	6·8	·520	66	0·155	W.	29·120	66·0	6·3	·532	63		N W.	66·7	4·7	(var.)	66·3	3·7	(var.)
23	29·873	·109	68·2	20	6·7	·383	45		N N E.	29·246	68·7	3·3	·442	55		(var.)	68·3	3·7	N W.	65·3	4·3	(var.)
24	29·933	·060	69.0	12	2·2	·369	38		W N W	29·245	68·3	2·3	·402	45		E.	72·7	5·0	E.	69·7	9·0	(var.)
25	29·871	·062	74·3	24	5·8	·566	52		S W.	29·206	70·7	6·7	·572	52		E.	75·0	2·3	S E.	74·0	4·3	?
26	29·691	·180	72·7	16	1·7	·594	58	0·063	S W.	29·045	68·0	7·0	·612	89	0·353	E.	72·0	3·0	W.	72·3	2·3	S W.
☽ 27	29·687	·073	59·8	16	9·8	·427	77	0·100	(var.)	29·008	68 3	5·0	·505	56	0·108	E.	64·0	11·3	S W.	58·7	13·7	?
28	29·718	·035	59·7	14	3·2	·534	84	0·005	N N E.	29·047	68·3	1·0	·420	68		W.	65·7	4·0	N W.	62·7	4·0	W.
29	29·887	·169	66·3	23	6·7	·344	40		N E.	29·215	70·7	2·7	·407	43		S E.	70·3	4·7	(var.)	69·0	6·3	(var.)
30	29 829	·085	64·3	18	4·0	·432	57	0·182	S E.	29·152	68·0	2·3	·608	50	0·128	S E.	71·0	4·0	S E.	71·7	6·0	(var.)
31	29·666	·163	72·3	20	8·0	·580	55	0·378	S.	29·021	70·0	3·0	·449	52		S E.	67.7	4·7	W.	64·7	7·0	W.
Means	29·810	·100	64·1	17	5·2	·421	57	3·589	N 59° E.	29·189	65·4	4·0	·459	60	6·343	S 87° E.	66·0	5·7	N 6° W.	64·4	6·3	N 60° W.

Abstract of Meteorological Observations for May, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

...Centre Co. ...° 53′ W. Height, ... Barcoon, Obs.		Somerset, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. Geo. Mowry, Observer.						
Rain.	Prevailing	Barom. Mean.		range.	2 P.M.	2 P.M.	Rain.	Prevail'g winds.
I(		Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
}(		7·642	42·7	8·0	·214	69	0·472	W.
}		7·679	45·3	5·3	·323	92	0·108	W.
		7·695	53·0	7·7	·289	41		N.
		7·602	61·7	8·7	·475	58		W.
		7·633	63·0	8·0	·374	36		W.
		7·628	70·0	7·0	·542	42		W.
•		7·625	70·7	5·0	·584	55	0·145	W.
		7·624	72·3	2·3	·555	45	0·101	S.
0		7·640	61·3	11·0	·447	77	1·069	S E.
2		7·567	56·0	5·3	·380	76	0·738	(var.)
0		7·657	58·3	2·3	·406	74	0·132	S E.
•		7·696	55·7	2·7	·391	87	0·890	S E.
0		7·657	62·7	7·0	·497	69	0·036	W.
0		7·604	61·3	4·0	·429	66		W.
		7·623	64·3	5·0	·549	67		S.
		7·647	63·0	2·7	·381	44		N.
		7·715	64·7	2·3	·484	52	1·156	(var.)
0		7·535	60·0	5·7	·475	69	0·202	(var.)
•		7·364	55·3	3·7	·316	62	0·076	W.
		7·577	56·0	8·3	·311	56		W.
1·		7·530	68·0	12·0	·564	69	0·132	(var.)
•		7·665	66·7	3·3	·573	58		WSW.
		7·471	63·3	5·3	·448	52		W.
		7·770	66·3	3·0	·491	52		(var.)
		7·683	69·7	3·3	·616	58	0·811	S E.
0		7·476	69·7	2·0	·650	66	0·060	(var.)
		7·506	60·0	6·7	·451	73	0·116	W.
		7·600	59·0	5·0	·413	62		W.
		7·703	64·0	5·5	·442	50		S E.
0		7·615	63·0	8·3	·436	60	0·409	S.
0·050	W.	27·544	63·0	6·7	·455	65	0·141	W.
7·435	s60°w.	27·625	61·6	5·4	·453	60	[illegible]	s34°w.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

SEPTEMBER, 1860.

CIVIL ENGINEERING.

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*Angular Troughs or Pipes, and Angular Bottoms to Drains.** By C. H. G. Thost.

Dissatisfied with the means of conveying the lead-ore from the mines to the stamping mills at Tyndrum Mines, I was led to devote my attention to the possibility of taking advantage of the moving power of water in close drains or pipes.

For this purpose a square pipe or trough was laid down from the entrance of the mine to the low grounds, a distance of 1200 feet, and having an inclination varying from 13 to 20 degrees. But though the water rushed through this pipe with great velocity, it failed to carry the fragments of ore along with it; these choked up the very mouth of the pipe. Having, therefore, failed in carrying out the idea in the square tube, numerous experiments were tried as to whether altering the form of the pipe would enable the object to be effected. The results showed such a superiority of the angular over the flat, curved, or other forms of bottom, that it was determined to try the experiment once more on the large scale with a tube of that form. The square box or pipe which had been laid down from the entrance of the mine to the low grounds was, therefore, as a preliminary turned on its edge, so that its bottom, instead of being flat, represented an angular channel, each side of which was inclined at an angle of 45°.

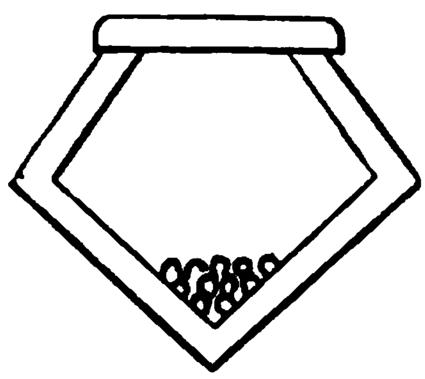
The lead ore, broken to the size of ordinary road metal, was fed by a hopper into the top of the tube; a moderate stream of water was admitted along with it, and the whole ore was passed through the tube

* From the London Civ. Eng. and Arch. Jour., March, 1860.

with an astonishing rapidity, and was delivered at the bottom, no choking taking place at all. Further experiments were made to ascertain the best angle at which the two sides of the base should meet, and it was found that a right angle answered all the purposes better than any other. With such an angle a smaller quantity of water was required to move the pieces of ore in the tubes; and the smallest gravel also, or even the powder of the ore, could be most effectually sent down.

The whole arrangements and general working of the mine were therefore modified so as to permit of this new mode of moving the ore being adopted; and now, not only is the whole ore conveyed by this means, but also all the residuary masses of quartz and other minerals which are cleaned from the lead ores previous to their transmission, are all got rid of by the same means, and deposited with little labor or expense in any desired locality.

To permit of the great wooden trough or pipe which conveys the ore from the mines to the low grounds being easily inspected and repaired, it is now made of the figure represented by the accompanying wood-cut, being in fact just the square box set on one of its angles, and having the upper angle sawn off. A movable cover is fixed securely down by means of cross bands of hoop iron, the ends of these bands being secured by means of iron pins, so that any part of the trough can be readily opened for repairs. The lower angle of the pipe is lined with hoop iron, as without this protection it was found that the angular fragments rapidly wore away the wooden sides. When thus protected, the friction against the sides seems to be much less than might have been anticipated.



Let us now consider the conditions under which the action of the water in moving these masses of ore down such a tube takes place. The resisting power or stability of a block of ore is diminished by the inclination of the tube and by the buoying-up power of the water; and the effectiveness of the action of the stream against the block is secured by the latter not being able to assume any firm position in the channel where it could escape that action. The inclined direction of the flat parts of the tube can offer no such hold to the block as it could obtain in the case of a flat bottomed channel. In the experiments with the flat bottomed tube, when the fragment fell on its flat side, there it stuck; but in the angular tube, from only touching the sides by one or more corners, it was in a position to be easily acted upon by the current.

The cost of this mode of conveyance may now be stated. The original cost of the angular wooden trough at Tyndrum, 1200 feet long, including all fittings, and lining the lower angle with hoop iron, was £70. This trough has been many years in use, and is still quite good; but the annual repairs, chiefly consisting of the renewal of the hoop iron lining, amount to £11 or thereabout. This trough conveys yearly to the low grounds from 1100 to 1200 tons of ore. The ore is supplied to the pipe through the mouth of a hopper; the person attending to

this is able, for the wages of one shilling, to get 40 tons down. This mode of conveyance is therefore the very cheapest yet tried, and as the same means are now applied to the removal of all the debris from the mines, the saving of expense is very considerable. The like system is now employed in the various processes of dressing and washing the ores, the troughs in these cases being open, and many of them are nearly level.

I wish to direct attention to the application of the angular form of bottom to ordinary drains and sewers. It is well known that the great object in giving a particular form to drains or sewers is to prevent the deposit and lodging of mud or sediment of any kind in them. Flat bottomed drains were found to silt up so soon that they have been generally abandoned; and as it was seen that circular pipes did not so easily become obstructed, some approach to the round form has been usually given, thereby incurring considerable expense. Now though sediment of any kind is much less liable to collect in these curved bottom drains, yet they are inferior in this respect to the drain with an angular bottom, as has been fully brought out during the numerous trials I had to make at Tyndrum before hitting on the angular form. And as I there found that even the finest powder of lead ore (which is many times heavier than ordinary mud or sand) was removed from these angular pipes even when at the most moderate inclinations, I am inclined to believe that the general adoption of the angular bottom for all kinds of drains would be a great improvement. In this form of bottom, however small the flow of water may be, it always runs at that part where the sediment can alone settle; and on the occurrence of any greater flow of water, either from heavy rains or occasional flushings, every particle of solid matter would be carried out of the drain. The adoption, then, of the angular bottom would not only appear to form a more perfect sewer than those at present in use, but from the cheaper character of the bottom a considerable saving in the original outlay would thereby be effected. The bottom angle might be constructed with brick in good cement, or be lined with hard flat stones; but the important point to be attended to is to make the junction at the angle perfectly secure.

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*On the Illumination of Light-houses—The Electric Light.** By M. FARADAY, D.C.L., F.R.S., Fullerian Professor of Chemistry, R.I., Foreign Associate of the Academy of Sciences, Paris, &c.

There is no part of my life which more than my connexion with the Trinity House gives me delight. The occupation of nations joined together to guide the mariner over the sea, to all a point of great interest, is infinitely more so to those who are concerned in the operations which they carry into effect, and it certainly has astonished me since I have been connected with the Trinity House to see how beautifully and how wonderfully shines forth amongst nations at large the desire to do good; and you will not regret having come here to-night, if you follow me

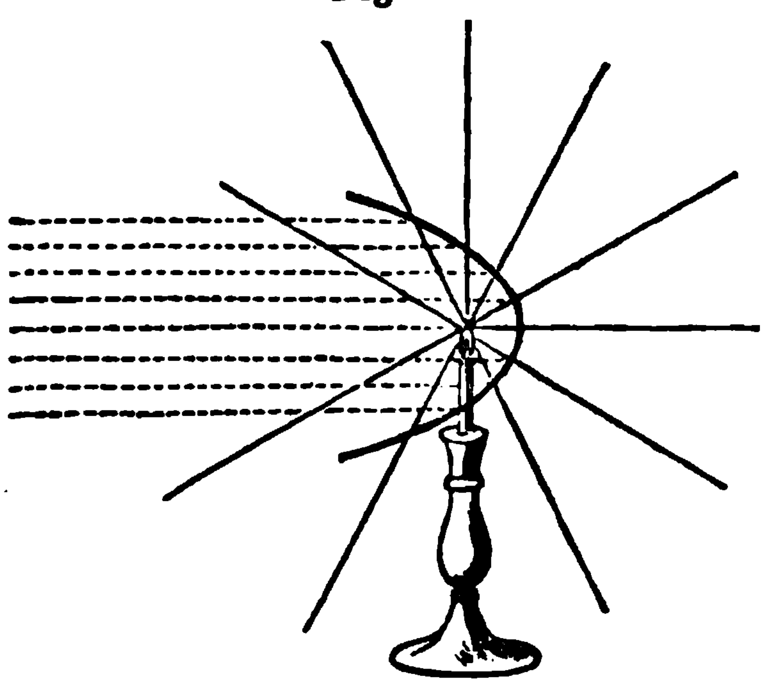
* From the London Chemical News, No. 15.

in the various attempts which have been made to carry out the great object of guiding in safety all people across the dark and dreary waste of waters. It is wonderful to think how eagerly efforts at improvement are made by the various public bodies—the Trinity House in this country, and commissions in France and other nations; and whilst the improvements progress we come to the knowledge of such curious difficulties and such odd modes of getting over those difficulties as are not easy to be conceived. I must ask you this evening to follow me from the simplest possible method of giving a sign by means of a light to persons at a distance, to the modes at which we have arrived in the present day; and to consider the difficulties which arise when carrying out these improvements to a practical result, and the extraordinary care which those who have to judge on these points must take in order to guard against the too hasty adoption of some fancied improvement, thus, as has happened in some few cases, doing harm instead of good.

If I try to make you understand these things partly by old models, and partly by those which we have here, it is only that I may the better be enabled to illustrate that which I look forward to as the higher mode of lighting, by means of the electric lamp and the lime light.

There is nothing more simple than a candle being set down in a cottage window to guide a husband to his home, but when we want to make a similar guide on a large scale, not merely over a river or over a moor, but over large expanses of sea, how can we then make the signal using only a candle? I have shown in this diagram (Fig. 1) what we may imagine to be the rays of a candle or any other source of light emanating from the centre of a sphere in all directions round to infinite distances. After this simple kind of light had been used for some time, it being found to be liable to be obscured by fogs, or distance, or other circumstance, there arose the attempt to make larger lights by means of fires; and after that there was introduced a very important refinement in the mode of dealing with the light, namely, the principle of reflection;—for understand this (which is not known by all, and not known by many who should know it), that when we take a source of light, a single candle, for instance, giving off any quantity of light, we can by no means increase that light; we can make arrangements around and about the light, as you see here, but we can by no means *increase the quantity* of light. The utmost I can do is to *direct* the light which the lamp gives me by taking a certain portion of the rays going off on one side and reflecting them on to the course of the rays which issue in the opposite direction. First of all, let us consider how we may gather in the rays of light which pass off from this candle. You will easily see that if I could take the half rays on the one side and could send them by any con-

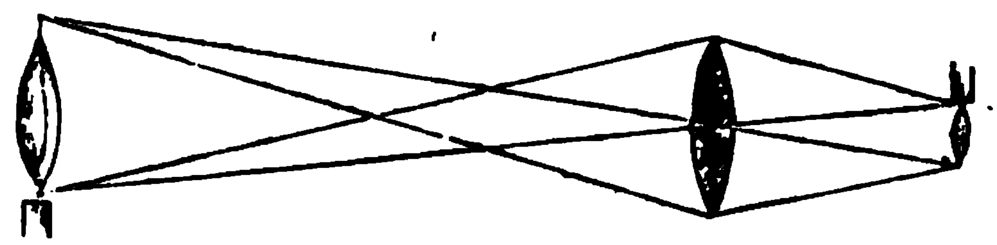
Fig. 1.



trivance over to the other side, I should gain an advantage in light on the side to which I directed them. This is effected in a beautiful manner by the parabolic mirror, by means of which I gather all that portion of the rays which are included in it; upwards, downwards, sideways, any where within its sphere of action; they are all picked up and sent forward. You thus see what a beautiful and important invention is that of the parabolic reflector for throwing forward the rays of light.

Before I go further into the subject of reflection let me point out a further mode of dealing with the direction of the light. For instance, here is a candle, and I can employ the principle of *refraction* to bend and direct the rays of light, and if I want to increase the light in any one direction I must either take a reflector or use the principle of refraction. I will place this lens (Fig. 2) in front of the candle and you

Fig. 2.



will easily see that by its means I can throw on to that sheet of paper a great light, that is to say, that instead of the light being thrown all about, it is *refracted* and concentrated on to that paper; so here I have another means of bending the light and sending it in one direction; and you see above a still better arrangement for the same purpose,—one which comes up to the maximum, I may say, of the ability of directing light by this means. You are aware that without that arrangement of glass the light would be dispersed in all directions, but the lens being there, all the light which passes through it is thrown into parallel beams and cast horizontally along. There is consequently no loss of light, the beam goes forward of the same dimensions, and will consequently continue to go forward for 5 or 10 miles, or so long as the imperfection of the atmosphere does not absorb it; and see! What a glorious power that is, to be able to convert what was just now darkness on that paper into brilliant light.

Whenever we have refraction of this sort we are liable to an evil consequent upon the necessary imperfections in the form of the lens; and Dr. Tyndall will take this lens, and will show you even in this small and perfect apparatus what is the evil of spherical aberration with which we have to fight. This can be illustrated by means of the electric lamp; if you look at the screen, you will see produced, by means of this lens, a figure of the coal points. This image is produced by the rays which pass through the *middle* of the lens, a piece of card with a hole in the centre being placed in front; but if, keeping the rest of the apparatus in the same position, I change this card for another piece which will only allow the rays to pass through the *edge* of the lens, you observe how inferior the image will be. In order to get it distinct I have to bring the screen much nearer the lamp; and so

if I take the card away altogether, and allow the light to pass through all parts of the lens, we cannot get a perfect image, because the different parts of the lens are not able to act together. This spherical aberration is, therefore, what we try to avoid by building up compound lenses in the manner here shown (Fig. 4). Look at this beautiful apparatus, is it not a most charming piece of workmanship? Buffon first and Fresnel afterwards, built up these kinds of lenses, ring within ring, each at its proper adjustment, to compensate for the effects of spherical aberration; the ring round that centre lens is ground so as to obviate what would otherwise give rise to spherical aberration, and the next ring being corrected in the same manner, you will perceive, if you look at the disc of light thrown by the apparatus up-stairs, that there is nothing like the amount of aberration that there would have been if it had been one great bulls-eye. Here is one of Fresnel's lamps of the fourth order so constructed (Fig. 3): observe the fine effect obtained by these different lenses as you see them revolve before you, and understand that all this upper part is made to form part of the lens, each prism throwing its rays to increase the effect, and, although you may think it is imperfect because if you happen to sit below or above the horizontal line, you perceive but little if any of the light, yet you must bear in mind that we want the rays to go in a straight line to the horizon. So that all that building up of rings of glass is for the purpose of producing one fine and glorious lens of a large size, to send the rays all in one direction. Here is another apparatus used to pull the rays down to a horizontal sheet of light, so that the mariner may see it as a constant and uniform fixed light; the former lamp is a revolving one, and the light is seen only at certain times as the lenses move round, and these are the points which make them valuable in their application.

Fig. 3.

There are various orders and sizes of lights in light-houses to shine for twenty or thirty miles over the sea, and to give indications according to the purposes for which they are required; but suppose we want more effect than is produced by these means, how are we to get more light? Here comes the difficulty. We cannot get more light, because we are limited by the condition of the burner. In any of these cases, if the spreading of the ray, or *divergence* as it is called, is not restrained, it soon fails from weakness, and if it does not diverge at all, it makes the light so small that perhaps one in a hundred can see it at the same time. The North Foreland light-house is, I think, 3 or 400 feet above the level of the sea, and therefore it is necessary to have a certain divergence of the beam of light in order that it may shine along

the sea to the horizon. I have drawn here two wedges, one has an angle of 15°, and shows you the manner in which the light opens out from this reflector seen at the distance of half a mile or more, the other wedge has an angle of 6°, which is the beautiful angle of Fresnel. When the angle is less than 6°, the mariner is not quite sure that he will see the light—he may be beneath or above it; and in practice it is found that we cannot have a larger angle than 15°, or a less one than 6°. In order, therefore, to get more light, we must have more combustion, more cotton, more oil; but already there are in that lamp four wicks put in concentric rings, one within the other, and we cannot increase them much more, owing to the divergence which would be caused by an increase in the size of the light—the more the divergence, the more the light is diffused and lost. We are, therefore, restrained by the condition of the light and the apparatus to a certain sized lamp. At Teignmouth, some of the revolving lights have ten lamps and reflectors, all throwing their light forward at once. But even with ten lamps and reflectors we do not get sufficient light, and we want, therefore, a means of getting a light more intense than a candle in the space of a candle—not merely an accumulation of candle upon candle, but a concentration into the space of a candle, of a greater amount of light, and it is here that the electric light comes to be of so much value.

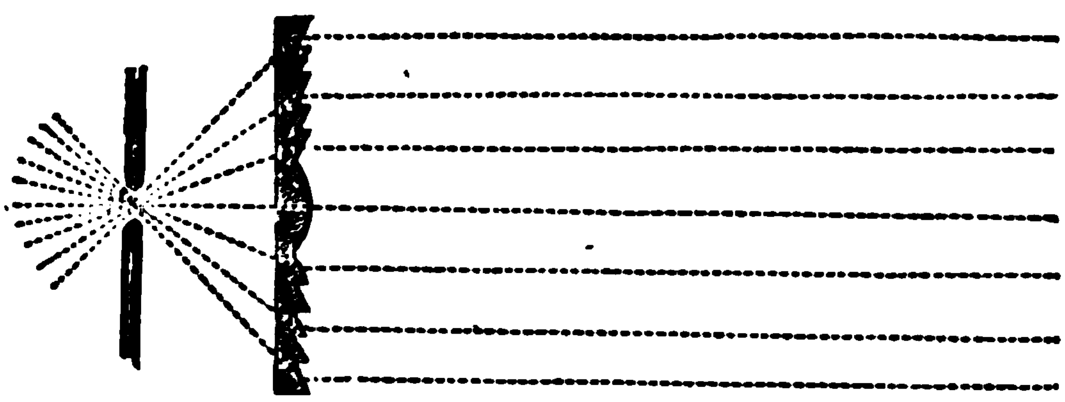
Let me now show you what are the properties of that light which make it useful for light-house illumination, and which has been brought to a practical condition by the energy and constancy of Prof. Holmes. I will first of all show you the image of the charcoal points on the screen, and draw your attention to the spot where the light is produced. There are the coal points. The two carbons are brought within a certain distance; the electricity is being urged across by the voltaic battery, and the coal points are brought into an intense state of ignition. You will observe that the light is essentially given by the carbons; you see that one is much more luminous than the other, and that is the end which principally form the spark, the other does not shine so much, and there is a space between the two, which, although not very luminous, is most important to the production of the light. Dr. Tyndall will help me in showing you that a blast of wind will blow out that light; the electric light can, in fact, be blown out easier than a candle. We have the power of getting our light where we please; if I cause the electricity to pass between carbon and mercury I get a most intense and beautiful light, most of it being given off from the portion of the mercury between the liquid and the solid pole. I can show you that the light is sometimes produced by the vapor between the two poles, better if I take silver than when I use mercury. Here is the carbon pole, there is the silver, and there is the beautiful green light which comes from the intervening portions. Now that light is more easily blown out than the common lamp, the slightest puff of wind being sufficient to extinguish it, as you will see if Dr. Tyndall breathes upon it.

You see, therefore, how we are able, by using this electric spark, to

get, first of all, the light into a very small space. That oil lamp has a burner 3¾ inches in diameter; compare the size of the flame with the space occupied by this electric light. Next compare the intensity of this light with any other; if I take this candle and place it by the side, I actually seem to put out the candle. We are thus able to get a light which, while it surpasses all others in brilliancy, is at the same time not too large, for I might put this light into an apparatus not larger than a hat, and yet I could count upon the rays being useful. Moreover, when such large burners are used in a lantern, we have to consider whether the bars of the window do not interfere to throw a shadow or otherwise; but with this light there will be no difficulty of that sort, as a single small speculum no larger than a hat will send it in any direction we please; and it is wonderful what advantages, by reason of its small bulk, we have in the consideration of the different kinds of apparatus required, reflecting or refracting, irrespective of other reasons for using the electric light. And it is these kind of things which make us decide most earnestly and carefully in favor of the electric light.

I am going to show you the effect that will take place with that large lens when we throw the oil lamp out of action, and put the electric light

Fig. 4.



into use. It is astonishing to find how little the eye can compare the relative intensities of two lights; look at that screen and try to recollect the amount of light thrown upon it from the 3¾ inch lamp of Fresnel, and now, when we shift the lens sideways, look at the glorious light arising from that small carbon point (Fig. 4); see how beautifully it shines in the focus of that lens and throws the rays forward. At present the electric light is put at just the same distance as the oil light, and therefore, being in the focus of the lens, we have parallel rays which are thrown forward in a perfectly straight line, as you will see by comparing the size of the lens with that of the light thrown on the screen. You will now see how far we can effect this beam of light by increasing or diminishing the distance of the lamp. We are able by a small adjustment to get a beam of a large or small angle, and observe what power I have now over it; for if I want to increase the degrees of divergence, I am limited by the power of light in the case of the oil lamp, but with the electric light I can make it spread over any width of the horizon by this simple adjustment. These then are some of the reasons which make it desirable to employ the electric light.

By means of a magnet, and of motion, we can get the same kind of electricity as I have here from the battery; and under the authority

of the Trinity House, Professor Holmes has been occupied in introducing the magneto-electric light in the light-house at the North Foreland; for the voltaic battery has been tried under every conceivable circumstance, and I take the liberty of saying it has hitherto proved a decided failure. Here, however, is an instrument wrought only by mechanical motion. The moment we give motion to this soft iron in front of the magnet, we get a spark. It is true in this apparatus it is very small, but it is sufficient for you to judge of its character. It is the *magneto-electric* light, and an instrument has been constructed as here shown (Fig. 5), which represents a number of magnets placed radially upon a wheel—three wheels of magnets and two sets of helices.

Fig. 5.

When the machine, which is worked by a two horse power engine, is properly set in motion, and the different currents are all brought together, and thrown by Professor Holmes up into the lantern, we have a light equal to the one we have been using this evening. For the last six months the North Foreland has been shining by means of this electric light—beyond all comparison better than its former light. It has shone into France, and has been seen there and taken notice of by the authorities, who work with beautiful accord with us in all these matters. Never for once during six months has it failed in doing its duty;—never once, more than was expected by the inventor. It has shone forth with its own peculiar character, and this even with the old apparatus—for as yet no attempt has been made to construct special reflectors or refractors for it, because it is not yet established. I will not tell you that the problem of employing the magneto-electric spark for light-house illumination is quite solved yet, although I desire it should be established most earnestly (for I regard this magnetic spark as one of my own offspring). The thing is not yet decidedly accomplished, and what the considerations of expense and other matters

may be, I cannot tell. I am only here to tell you as a philosopher, how far the results have been carried, but I do hope that the authorities will find it a proper thing to carry out in full. If it cannot be introduced at all the light-houses, if it can only be used at one, why really it will be an honor to the nation which can originate such an improvement as this,—one which must of necessity be followed by other nations.

You may ask, what is the use of this bright light? It would not be useful to us were it not for the constant changes which are taking place in the atmosphere, which is never pure. Even when we can see the stars clearly on a bright night it is not a pure atmosphere. The light of a light-house, more than any other, is liable to be dimmed by vapors and fogs, and where we most want this great power, is not in the finest condition of the atmosphere, but when the mariner is in danger, when the sleet and rain are falling, and the fogs arise, and the winds are blowing, and he is nearing coasts where the water is shallow and abounds with rocks—then is his time of danger, when he most wants this light. I am going to show you how, by means of a little steam, I can completely obscure this glorious sun, this electric light which you see. The cloud now obscuring the light on the screen is only such a cloud as you see when sitting in a train on a fine summer's day; you may observe that the vapor, passing out of the funnel, casts as deep a shadow on the ground as the black funnel; the very sun itself is extinguished by the steam from the funnel, so that it cannot give any light; and the sun itself if set in the light-house would not be able to penetrate such a vapor.

Now the haze of this cloud of steam is just what we have to overcome, and the electric light is as soon, proportionally, extinguished by an obstruction of this kind as any other light. If we take two lights, one four times the intensity of the other, and we extinguish half of one by a vapor, we extinguish half of the other, and that is a fact which cannot be set aside by any arrangement. But then we fall back upon the *amount* of light which the electric spark does give us in aid of the power of penetrating the fog, for the light of the electric spark shines so far at times, that even before it has arisen above the horizon twenty-five miles off, it can be seen. This intense light has, therefore, that power which we can take advantage of,—of bearing a great deal of obstruction before it is entirely obscured by fogs or otherwise.

Taking care that we do not lead our authorities into error by the advice given, we hope that we shall soon be able to recommend the Trinity House, from what has passed, to establish either one or more good electric lights in this country.

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*Increase of the Bite of Locomotives on Railways.**

In another part of our impression we give an account of an invention, with some experiments, of Mr. E. W. Serrell, an American civil engineer, from the *Journal of the Franklin Institute*, for increasing the bite of the engine wheels on the rails by means of electro-magnet-

* From Herapath's Railway Journal, No. 1071.

ism. Though we admit the importance of the invention, if generally practicable, we cannot see that it will allow of so much reduction in the weight of the locomotive, though it would of some, as the inventor seems to think. The power of the engine resides in its boiler, every part of which, with the working gear and driving wheels, must have strength with proportional weight to bear the full, and more than the full, strain of the steam in the boiler, and to resist the shocks occasioned by the velocity on the road. There is, however, one great benefit the invention would confer both upon the traveling public and the railway Companies. It would go far to lessen the number of accidents by the engine leaving the rails. For if the mutual adhesion between the wheels and rails be increased, the chances of the engine jumping off the rails will be diminished, and that would be more particulary so if the driving wheels, as we have heretofore recommended, were placed in the fore part of the engine. Coupled engines, too, which on curved lines produce great strains and consequent wear and tear, would be less needful if Mr. Serrell's invention could be brought into use.

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*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M. A., F. R. S.

[The following Lecture was delivered at the Royal Institution on the 24th May, 1860.]

The subject of my present lecture is eminently practical, and hardly admits of much variety of illustration; but I am sure that none of you can have examined, or even glanced at the numerous specimens of architectural construction in the older and more picturesque cities of England and the Continent—you cannot have admired the graceful tracery of Westminster Abbey,—you cannot even have looked at the rich detail of the noble building recently erected so near it, by one whose genius will, perhaps, be willingly acknowledged, now that he has departed from amongst us, without noticing the facts I am about to refer to.

You will there see, at every turn, fresh proof of apparently capricious and unaccountable decay. You will find many old stones unaltered, while many new ones are fast mouldering into rottenness; and you will, I believe, be interested, in spite of the apparent dryness of the subject, in anything that will inform you about a result so painful, so irregular, and so desirable to check, if in any way prevention is possible.

Our building materials are of several kinds. Let me point out to you the principal varieties—their peculiar uses—their relative value for special purposes—and the special causes of decay in each. I shall then endeavor to put before you the modes by which such materials may be, at least in some measure, preserved from decay.

There is one thing which I may say with regard to all building materials of the nature of stone,—namely, that wherever it is found forming part of the earth's crust as a mass of rock, it is invariably,—if it comes to the surface at all—injured and altered near the surface. In

* From the Journal of the Society of Arts, No. 396.

a granite district, for example, where there is scarcely any soil lying over the granite, it scarcely ever happens that the upper portion of the granite does not, to a certain extent, exhibit marks of alteration. In all the common absorbent stones which are ordinarily used for building purposes, this is much more remarkably the case. And, to a certain extent, the rate at which the stone would be injured may be estimated by its appearance where it has been thus exposed for a long time to the action of the atmosphere. But that can only be taken as a partial measure of the injury likely to occur, because in some cases it will happen that the stone will stand exposure perfectly well in its own atmosphere, and when the surface only is exposed, without having been removed from the bed, although that same stone, when it is removed from the bed, particularly when it is placed in a different position from that which it occupied in the bed, will decay much more rapidly. Still, as I have said, it is an indication, and you will generally find that in a granite district a surface of good granite is exceedingly hard close to the top, and a decomposing granite worn and rotten. In a sandstone district there will also be a certain amount of decomposition dependent on the value of the stone. And in a limestone district there will generally be considerable decomposition; in fact the whole of the upper bed of limestone will be converted into vegetable soil.

Let us now take the building materials in regular order. First of all there is the group of which granite is the representative. A very remarkable group of stones is this, which are perfectly familiar to every one. With respect to it, therefore, I shall not waste your time in definitions, and merely remark that as it is one of the hardest, and, in some respects, one of the most valuable stones we have, yet in many respects, although very useful, it is almost impracticable for delicate ornamentation. Granite consists of a number of crystals embedded in a crystalline base. In other words, it is a mass of crystalline minerals crystallized altogether. That is the essential nature of granite, and the point in which it differs from most other stones. This explains at once its value, and the nature of its decay. Its value, because granite, being composed entirely of crystallized matter, is non-absorbent, and very little exposed to injury, so that there is no opportunity for decomposing agencies to get to it, without the lapse of a very long period of time. But it is also necessary to observe that granite consists of various kinds of crystals, and these not being always composed in the same manner, some are more liable to decay than others. Among the crystals that form granite are crystals of quartz, a material so durable that one hardly expects it to fail at all. But quartz, under certain circumstances, is capable of assuming a state in which, by the action of the weather, it will decay. This very peculiar state I shall speak of afterwards, when I have to ask your attention to some means of preventing decay. It is a fact—and I allude to it now as one of the ways in which granite appears subject to decay. A portion of quartz seems to be liable, in some states, to combine with water; and it then can be acted upon by alkalies and alkaline carbonates. More frequently it is the crystals of felspar, of which granite also consists in

a large measure, that decay. These consist of compound silicates, and the alkali among them is generally potash, but occasionally soda. When the alkali is soda, the stone is more likely to decay than when it is potash. Mica or talc, the other constituent of granite, is in a similar way liable to decomposition. Thus, although granite, as a stone, seems scarcely liable to injury, yet all the different parts of it are really capable of decay. With regard to the prevention of granite from decay, I do not know that it has ever been attempted. The only thing to be done is to select the better kinds, and you have only to go to the British Museum, and look at those wonderful specimens which have been delicately sculptured by the Egyptians, and afterwards exposed for so many centuries to a dry atmosphere, and now for some years to our own moist atmosphere, to observe how totally untouched they are. You have only to look at the various specimens of granite in our own metropolis, or in other parts of our island, and you cannot fail of being convinced how well it stands generally, although you may occasionally find unfavorable specimens.

Granite is a material which, owing to its great hardness, requires to be worked by pick and wedge; it cannot be worked merely by chisel and mallet. Owing to that it is expensive, and, generally speaking, cannot be used for ordinary purposes.

Next we come to the group of freestones. Freestones are either sandstones or limestones. The sandstones form a large group, but they are not very extensively used for the more decorative parts of buildings. They are at any rate little used in London, and there are many reasons for this. Sandstone consists for the most part of quartz sand, and I have told you that quartz forms a larger part of granite. But the particles of quartz in sandstone are cemented together by some foreign combining substance; sometimes this substance is silica, and in that case the stone will be almost unchangeable. Such is the sandstone that is worked in Edinburgh, and obtained at Craigleith. It is a stone which scarcely injures by exposure. Most of the sandstones, however, are cemented together, either by carbonate of lime, which has been filtered in by the action of water, by a mixture of clay and carbonate of lime introduced in the same manner, or by the presence of oxide of iron. All these cementing media are of course liable to the action of foreign substances upon them, according to their nature. And if these give way it is clear that the stone itself must give way. For an example of this kind of stone, that scarcely changes at all, I may direct your attention to a few specimens of the Yorkshire stones on the table before you. Although very excellent, however, these stones are not very manageable. They are difficult to work, and very hard. Although very durable, they vary, and are not quite free from the ordinary faults of sandstone. There is also before you a specimen of red stone (Mansfield) in which there is a considerable quantity of iron. The others are silica, with some mica, and are cemented by calcareous and argillaceous matter. They are thus liable to the ordinary action of weather and foreign substances upon them. In these stones the particles of silica rarely, if ever, give way, but

they are liable to fall away from each other by the decomposition of their cementing medium. But I was going to speak of the several kinds of sandstone before going into the causes of decay. The Yorkshire stones are the next in value after Craigleith, and are very good. Some of the dark-colored Scotch stones are also excellent. The stones from the coal measures are better than these red ones, which are not by any means advisable, and require to be used with care. There are a number of varieties of these red sandstones. All the sandstones used may be grouped in these three ways:—Those that are very hard, very compact, very fine in grain, and, generally speaking, of a pale color; these are durable but costly. Next, there are those that are hard and laminated. That is the character which belongs to almost all rocks that have been found in water, but in some it shows itself more markedly than in others. In stones which are completely laminated, the appearance is like sheets of paper placed one over the other, and you can almost separate them. Those stones are easily perishable. There are, however, laminated stones, such as those I am now referring to, of good quality. These are generally, not of very fine grain, although they may be so. They are most frequently of a mixed grain, made up of particles of sand and small pebbles of different sizes. Very often they have reddish tints of color, owing to the presence of iron, and they are often very irregular in their character. Lastly, there are some soft stones which are laminated, and generally red, but soft and bad. These are the three kinds of stone.

All these stones are subject to decay in this way:—First, from the lamination. Having been formed in water, they have been deposited in beds one over the other, and never become entirely free from water, and when exposed to the air are liable to give off the water by evaporation, and take it in again by absorption when rain comes, or when the atmosphere is damp. After this, if a change of temperature follows, and a severe cold sets in, the temperature of the stone passing below the point of the extreme density of water, the water begins to expand. That expansion before and whilst freezing, is one of the properties of water with which you are probably acquainted. You all know that if you leave water in a jug with a narrow neck, and frost sets in, the water will expand and break the jug. In the same way laminated and absorbent stones will break. The water gets in but cannot get out freely. It expands, and the stone breaks. Secondly, water entering in the manner I have described contains foreign substances. The water in the atmosphere that falls in the shape of rain is absorbed into the stone, and necessarily contains these foreign substances floating in the atmosphere which are soluble in water. These substances include a large number of gases—acid gases for the most part—but some others. For example, they include carbonic acid gas, and carbonic acid dissolves in water; they include, also, sulphurous acid passing into sulphuric acid, and this is taken up by the water. They include, also, ammonia. All these substances are abundantly produced in the atmosphere of large towns. These substances entering into the body of the stone, begin to act upon the cementing me-

dium. If the cementing medium is easily acted on chemically by these substances, it is of course very soon removed. If it is not easily affected by them, then the stone remains unaltered; but, generally speaking, it is the case that sandstones that have either lime or clay as their cementing medium, are more or less affected by foreign substances entering into them through the atmosphere. There is then a cause of decay in the sandstones, and the sandstones, when they are very absorbent, generally become readily disintegrated in this manner. Sandstones are not very extensively used in London for building, but they are very much employed in many parts of the country.

The next group includes what we call limestones. Limestones differ more in their nature than sandstones do, and include different kinds of material. For example, there are the carbonates of lime pure and the carbonates of lime and magnesia. First of all, I will take the carbonates of lime. Some of these are perfectly crystalline, such as marble. Marble has a very close texture; it does not absorb water, and it is, therefore, little acted upon by it unless it contains acids. When sound it lasts a long time, but if cracked, decay will enter in where the crack occurs. Marble is a very expensive stone, and the quantity of it compared with the other kinds of limestone is small; but there is a good deal of a sort of limestone intermediate between marble and common oolites. This is generally hard, and not unfrequently contains thin strings of foreign substances, as silica, which interfere with its working. Such stones are found in Derbyshire, and belong to what geologists call the carboniferous or mountain limestone series. They are crystalline, but irregular, being partially cracked and containing many fossils. A large majority of the limestones used in this country are oolites, so called because they appear to be made up of a number of eggs. These oolites are of various qualities. They are found in many parts of the country, and are commonly used for building, being, in fact, our common materials. There are several varieties of them which are of different value. One of the best is the Portland stone. There is a specimen upon the table, and a very good specimen it is. These stones are made up of a number of little particles, which are themselves groups of smaller particles. These little particles are cemented together by carbonate of lime, and the whole stone is nearly pure carbonate of lime. Portland is probably the best building stone we have in England, but is dear, being hard and expensive to work. St. Paul's Cathedral is built of Portland stone, and so is Greenwich Hospital, both being excellent examples. It is impossible, perhaps, to find better specimens of this stone than the Hospital. A few days before his death, I was with Sir Charles Barry at Greenwich Hospital, and he was pointing out to me the beautiful condition of the stone on the east face. It is, indeed, worth looking at as a specimen of the material, and is almost, if not quite, equal to the marble of which the Milan Cathedral is built. There are many other good specimens of this stone in London, and of these the Reform Club is as good as any. If you look at these specimens of

the better kind, you will hardly recognise the decay that takes place. You must look at stones which have been a long time exposed, or else at an inferior quality of material. Bath stones offer a wonderful contrast to Portland. Bath stone is almost as soft as cheese in the quarry, and it can then be cut with an ordinary knife. I speak now of the stones in the quarry, where all stones are softer and more easily worked than when they have been exposed for some time to the air. Bath stone, being exceedingly soft, is therefore cheap. It is easily got and easily cut, but it is not a stone that wears well. Some specimens of Bath stone are to be seen in the recent restorations of Westminster Abbey that have failed so completely as to be already a great deal worse than much of the stone that has been there for centuries. Within the few years that have elapsed since this stone was put up, it has decayed entirely. And yet stones of the same kind, from nearly the same quarry—indeed some from the identical quarries—have been used in the City of Bath, and are not much the worse after a century's wear. There is a difference in the quality of the stone, but there is also a great difference in the quality of the air to which stones are exposed. The rapid decay may, however, be partly attributed to the fact that the stones for Westminster Abbey had not been well selected, and perhaps the stones used at Bath had been for some time exposed to the air before use. Bath stone is, as I have said, an exact opposite to Portland. But we have other stones that are bad. I do not know that I can mention a more remarkable instance than the stone which is obtained at Heddington, in the neighborhood of Oxford. There are some specimens of the different oolites on the table, and the Heddington is in some respects the worst of all. No one, I think, can have looked at some of the older buildings in Oxford without seeing what a bad state they are in, and how bad the stone itself must be. I have here a specimen of Heddington stone, that has been exposed for a short time to the action of acids, and it shows the way in which such stones will decay. Besides these there are a number of stones of intermediate quality in England, known by various names—the names of the quarries in which they are found. There is the Ancaster stone, the Ketton stone, the Barnack stone, and the Purbeck stone. There is another limestone to which I wish to direct your attention—that is the Caen stone. A vast quantity of stone has been obtained, from time immemorial, from some of the quarries in the neighborhood of Caen, and some other places near. This stone has been brought over to England almost from the time of the Norman conquest. Part of Canterbury Cathedral is built of it, and it has stood very well. But other stones from the same or from adjacent quarries have gone entirely. They have failed so thoroughly that it is impossible to conceive any thing worse. They are even worse than the Heddington stone in the worst cases in Oxford. There is a specimen before me of Caen stone showing decay; it shows the quality of the stone, and it shows the way in which decay takes place. This, however, although a decayed stone, is not a bad specimen. I could not get the sort of specimen I should have been glad of, to show how badly some Caen

stone decays. But there have been some buildings erected lately in London, and I am sorry to say that one of them is Buckingham Palace, that show the decay as clearly as can be. Soon after the palace was completed, the stone became in so bad a state that it was positively dangerous for the sentinels to walk underneath it, and it was necessary to remove large portions of it and to substitute stucco; and there it remains to this day painted over. This case, with regard to a common limestone will show what sort of material we have to deal with. All the cheaper kinds of stone are exceedingly liable to decay.

How does limestone decay? It decays in a very simple way, and from the same causes that I alluded to in speaking of sandstones.—First there is an exposure to changing temperature, all the limestones being absorbent, and taking in a certain quantity of water. The water is driven in by rain, particularly in what appear to be the sheltered parts of the stone, beneath projections. Then cold comes, and even if the stone has been placed in the building as it lays in the bed, there will still be a tendency to throw off successive laminæ, but if put carelessly in the building, or fixed at right angles to the position it was in the bed, so that what was originally the plane of the bed has now become vertical, the effect will be that the whole face of the stone will peal off, and if the stone is cut into delicate ornaments, it is almost inevitable that some of the planes of the bed would interfere, so that when expansion takes place, the outer laminæ of the ornament would break off and fall away. The moment that is done in any one place, absorption becomes more rapid than it was before, and it goes on with increasing rapidity. If, however, the stone lasts for a certain time without injury, the surface hardens. All stone is much harder after it has been exposed to the air for some time than it is in the quarry; and, therefore, if it once gets into this state it may last, but if it is attacked early it will go. There is an instance of this to be seen in Mr. Hope's house, in Piccadilly, which is built of a soft stone. It has been sheltered by putting leads over the tops of the exposed parts; and I have Mr. Charles Smith's authority for saying that, in consequence of that, the stone has been preserved. The water has been prevented from draining down into the stone, and in that way it has had time to harden. The water that is absorbed when limestone is exposed to the air is charged with acids, as I have already mentioned, and under these circumstances the stone acts as a kind of filter. A porous stone acts also in another way, decomposing the gases that pass into it. A certain, though slow, decomposition thus goes on, and the stone becomes actually destroyed. Very often this will take place even when it is not very apparent outside. That is the case especially in some of the Heddington stones. At Oxford you will often see large scales breaking off from the surface of the building, although the outside is apparently pretty good. This is the result of that amount of decomposition and alteration that goes on within the substance of the stone itself.

There is another kind of limestone which I must mention. It is magnesian limestone. The magnesian limestone is carbonate of lime

and magnesia; common limestone is simply carbonate of lime. Just as the common limestone when crystallized is very durable, so magnesian limestone, when crystallized (in which case it is composed of equal parts of carbonate of lime and carbonate of magnesia), is in a more compact state than when earthy, and then seems to stand exceedingly well. In the places where these stones are obtained, the churches built of them centuries ago are quite unaltered. But when these same stones are brought into our London atmosphere, although they appear to be just as good, and are exposed to very much the same influences, they begin at once to decay. It was owing to a neglect of the consideration of this matter that the stone used for the construction of the Houses of Parliament has suffered so much. The stone for this purpose was selected with the greatest possible consideration. A commission was appointed of the fittest men of the time—the best geologist, the architect, competent practical men, and the best chemists. All those employed were men of the highest reputation, and no one has hinted for a moment that they did not do their duty. This commission examined the different limestones in the country, and they recommended the magnesian limestone of Bolstover, because they believed it to be the best. They found buildings constructed of it many centuries ago entirely unaltered, and they naturally recommended that it should be employed. Then came a difficulty which had not been considered sufficiently, and that was that the particular quarries which had supplied the stone to the churches in the neighborhood were by no means large enough to supply the quantity required for the Houses of Parliament; and not only that, but it was not at all certain that other stones could be got in the immediate neighborhood of precisely the same kind. Other quarries adjacent were selected, and the stone which was used was certainly from the neighborhood, and nominally the same stone, but really it was exceedingly imperfect. Magnesian limestone differs from common limestone in the way in which it decays. Under the action of those causes that I have already mentioned, it decays whenever the two minerals are not perfectly crystallized together, and then it becomes disintegrated and powdery, so that in one block you will find portions which are perfectly hard, and other portions near them, which are also hard, whilst between these two you will find portions which are perfectly soft, and so disintegrated that the particles might almost be blown away by the wind. This has arisen from the way in which the material was originally crystallized, and from the difficulty that there is in producing a perfect crystallization in a mass on a large scale in nature. Generally speaking, there is a considerable amount of variety both in the composition and subsequent metamorphosis of rocks, so that bedded materials almost always vary a great deal even in a short distance. This is the case with magnesian limestone, but it also appears that neglect was incurred by the want of sufficient superintendence in selecting the best kinds of stone, and rejecting bad samples either at the quarry or in London. There was no sufficient superintendence, and the poor and inferior specimens of stone were not rejected. They were all put into this

great building, and the result is that some of the stones are very good, some very indifferent, and some exceedingly bad. The same kind of stone was used in the new building of Lincoln's-inn, and it is even worse. The same kind of stone, however, is used in the construction of the Museum of Practical Geology, in Jermyn-street, and there there is not a stone faulty. It would appear then that the selection of stone is a very important matter. So much I may say with regard to the materials and the nature of the causes that produce their decay.

Practically, then, the causes of decay of absorbent stones are connected with exposure to damp atmosphere, rendered impure by various acids and alkaline gases, and also with changes of temperature, especially above and below the temperature of about 38 degrees, at which water attains its greatest density. It is quite clear that where there is a large amount of injurious gases present in the air, in other words in and near large cities, where there are a great number of people breathing and giving off carbonic acid gas, and where a large number of fires are burning, which always yield a large quantity of sulphurous acid, and also where there is much ammonia; in these places, and owing to the state of the atmosphere, stones which in the open country would stand perfectly well, will stand very badly. In addition to this must be taken into account the exposure to certain winds, and the action of the weather to a greater or less extent for a limited time.

(To be Continued.)

MECHANICS, PHYSICS, AND CHEMISTRY.

*The Mechanical Theory of Heat.** By DANIEL K. CLARK, C. E.

An important an interesting inquiry relative to steam and its operation in the steam engine, is that which traces the connexion between the heat expended and the dynamical effect, or work, produced. The method of separate condensation, and the application of the force of expanding steam, changed to an important extent the accepted relations of heat to power, and added remarkably to the dynamical effect of the fuel; and though the steam engine has been progressively improved by the continual elaboration of small economies, there is yet good reason to believe that the field of improvement is wide, and that the laborer in that field has the prospect of a good return. The inquiries of scientific men on the subject of the relation of heat to mechanical effect have resulted in the establishment of the principle that heat and mechanical force are identical and convertible, and that the action of a given quantity of heat may be represented by a constant quantity of mechanical work performed. "Motion and force," says Professor Rankine, "being the only phenomena of which we thoroughly and exactly know the laws, and mechanics the only complete physical science, it has been the constant endeavor of natural philosophers, by conceiving the other phenomena of nature as modifications of mo-

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tion and force, to reduce the other physical sciences to branches of mechanics. Newton expresses a wish for the extension of this kind of investigation. The theory of radiant heat and light having been reduced to a branch of mechanics by means of the hypothesis of undulations, it is the object of the hypothesis of molecular vortices"—oscillation of vibratory motion—"to reduce the theory of thermometric heat, and elasticity also, to a branch of mechanics, by so conceiving the molecular structure of matter that the laws of these phenomena shall be the consequences of those of motion and force. This hypothesis, like all others, is neither demonstrably true nor demonstrably false, but merely probable in proportion to the extent of the class of facts with which its consequences agree." It must, however, be remarked that, whether the hypothesis of molecular motion be probable or improbable, the theoretical and practical results arrived at in regard to the mechanical action of heat remaining unaffected, being deduced from principles which have been established by experiment and demonstration. From these principles, Professor Rankine announced the specific heat of air before it was otherwise known—the accuracy of his deductions having since been verified to within less than 1 per cent. by the experiments of Regnault. The best experiments, previous to those made by Regnault, in regard to the specific heat of air, were those of Delaroche and Berard, from which they deduced a specific heat of ·266; but arguing from the mechanical theory of heat, Professor Rankine declared that this value must be erroneous, and that the specific heat of air could not exceed ·240. It has been found accordingly, by Regnault, since the statement was made, as the result of a hundred experiments, that the specific heat of air was ·238, and that it is constant for all pressures from one to ten atmospheres, or at least differs almost inappreciably. This coincidence of theoretical prediction with experimental evidence, it has been well observed, should have something like the same tendency in strengthening our belief of the theory upon which Prof. Rankine's estimate was based, as the discovery of an unknown planet, previously indicated by Le Verrier and Adams, had in confirming our faith in the science of astronomy.

The principle of the dynamical or mechanical theory of heat, as already stated, is that, independently of the medium through which heat may be developed into mechanical action, the same quantity of heat converted is invariably resolved in the same total quantity of mechanical action. For the exact expression of this relation, of course units of measure are established, in terms of the English foot, as the measure of space; the pound avoirdupois, as the measure of weight, pressure, elasticity; and the degree of Fahrenheit's scale, as the measure of temperature and heat. Work done consists of the exertion of pressure through space, and the English unit of work is the exertion of 1 lb. of pressure through 1 ft., or the raising of 1 lb. weight through a vertical height of 1 ft.—briefly, a foot-pound. The unit of heat is that which raises the temperature of 1 lb. of ordinary cold water by 1 deg. Fah. If 2 lbs. of water be raised 1 deg., or 1 lb. be

raised 2 deg. in temperature, the expenditure of heat is, equally in both cases, two units of heat. Similarly, if 1 lb. weight be raised through 1 ft., or 2 lbs. weight be raised through 2 ft., the power expended, or work done, is equally in both cases two units of work, or two foot-pounds. From these definitions, then, the comparison lies between the unit of heat, on the one part, and the unit of work, or the foot-pound, on the other. M. Clapeyron, in his treatise on the moving power of heat, and M. Noltzman, of Manheim, in 1845, who availed himself of the labors of M. Clapeyron and M. Carnot in the same field, grounding their investigations on the received laws of Boyle or Marriotte, and Gay-Lussac, which express the observed relations of heat, elasticity, and volume in steam and other gaseous matter, concluded that the unit of heat was capable of raising a weight, between the limits of 626 lbs. and 782 lbs. 1 ft. high; that is to say, that one unit of heat was equivalent to from 626 to 782 foot-pounds. By this mode of investigation, they suppose a given weight of steam or gaseous matter to be contained in a vertical cylinder formed of non-conducting material, in which is fitted an air-tight but freely moving piston, which is pressed downward by a weight equal to the elasticity of the gas. Now, the weight, initial temperature, pressure, and volume being known, a definite quantity of heat from without is supposed to be imparted to the vapor; and the result is partly an elevation of the temperature of the vapor, and partly a dilation or increase of volume; or, in other words, an exertion of pressure through space, the elasticity remaining the same. But the result may be represented entirely by dilation, so that there shall not be any final alteration of temperature; and for this purpose it is only necessary to allow the vapor to dilate without any loss of its original or imparted heat until it re-acquires its initial temperature. In this case, the ultimate effect is purely dilatation, or motion against pressure; and the work done is represented by the product of that pressure into the space moved through.

Mr. Joule, of Manchester, in 1843–47, proceeded, by entirely different, independent, and, in fact, purely experimental methods, to investigate the relation of heat and work. 1st. By observing the calorific effects of magneto-electricity. He caused to revolve a small compound electro-magnet immersed in a glass vessel containing water between the poles of a powerful magnet: heat was proved to be excited by the machine by the change of temperature in the water surrounding it, and its mechanical effect was measured by the motion of such weights as by their descent were sufficient to keep the machine in motion at any assigned velocity. 2d. By observing the changes of temperature produced by the rarefaction and condensation of air. In this case, the mechanical force producing compression being known, the heat excited was measured by observing the changes of temperature of the water in which the condensing apparatus was immersed. 3d. By observing the heat evolved by the friction of fluids. A brass paddle-wheel, in a copper can containing the fluid, was made to revolve by descending weights. Sperm oil and water yielded the same results. Mr. Joule considered the third method the most likely to afford accu-

rate results; and he arrived at the conclusion that one unit of heat was capable of raising 772 lbs. 1 ft. in height; or that the mechanical equivalent of heat was expressible by 772 foot-pounds for one unit of heat—known as "Joule's equivalent."

The following are the values of Joule's equivalent for different thermometric scales, and in English and French units:—

1 English thermal unit, or 1 deg. Fah. in 1 lb. of water,	772 foot-pounds.
1 centigrade degree in 1 lb. of water, . . .	1389·6 "
1 French thermal unit, or 1 centigrade degree in a kilogramme of water, ...	423·55 kilogrammetres.

The mechanical theory of heat rests upon a wide basis, and proofs in verification of the theory are constantly accumulating. When the weight of any liquid whatever is known, with the comparative weight of its vapor at different pressures, the latent heat at the different pressures is readily estimated from the theory; and this method of estimation agrees with the best experimental results, as may afterwards be shown; and when the latent heat is also known, the specific heat of the liquid can be determined by means of the same theory; in other words, the quantity of work, in foot-pounds, may be determined, which would, by agitating the liquid or by friction, be required to raise the temperature of any given quantity of the liquid by, say, one degree, altogether independently of Joule's experiments. The theory enables us to discover the utmost power it is possible to realize from the combination of any given weight of carbon and oxgyen, or other elementary substances, with nearly as much precision as we can estimate the utmost quantity of work it is possible to obtain from a known weight of water falling through a given height. It is not difficult to comprehend, then, that the theory of the mechanical equivalent of heat proves of great practical utility.

According to the mechanical theory of heat, in its general form, heat, mechanical force, electricity, chemical affinity, light, sound, are but different manifestations of motion. Dulong and Gay-Lussac proved by their experiments on sound, that the greater the specific heat of a gas, the more rapid are its atomic vibrations. Elevation of temperature does not alter the rapidity, but increases the length of their vibrations, and in consequence produces "expansion" of the body. All gases and vapors are assumed to consist of numerous small atoms, moving or vibrating in all directions with great rapidity; but the average velocity of these vibrations can be estimated when the pressure and weight of any given volume of gas is known, pressure being, as explained by Joule, the impact of those numerous small atoms striking in all directions, and against the sides of the vessel containing the gas. The greater the number of these atoms, or the greater their aggregate weight, in a given space, and the higher the velocity, the greater is the pressure. A double weight of a perfect gas, when confined in the same space, and vibrating with the same velocity—that is, having the same temperature—gives a double pressure; but the same weight of gas, confined in the same space, will, when the atoms vibrate with a double velocity, give a quadruple pressure. An increase

or decrease of temperature is simply an increase or decrease of molecular motion. The truth of this hypothesis is very well established, as already intimated, by the numerous experimental facts with which it is in harmony.

When a gas is confined in a cylinder under a piston, so long as no motion is given to the piston, the atoms, in striking, will rebound from the piston after impact with the same velocity with which they approached it, and no motion will be lost by the atoms. But when the piston yields to the pressure, the atoms will not rebound from it with the same velocity with which they strike, but will return after each succeeding blow, with a velocity continually decreasing as the piston continues to recede, and the length of the vibrations will be diminished. The motion gained by the piston will, it is obvious, be precisely equivalent to the energy, heat, or molecular motion lost by the atoms of the gas. Vibratory motion or heat being converted into its equivalent of onward motion, or dynamical effect, the conversion of heat into power, or of power into heat, is thus simply a transference of motion; and it would be as reasonable to expect one billiard-ball to strike and give motion to another without losing any of its own motion, as to suppose that the piston of a steam engine can be set in motion without a corresponding quantity of energy being lost by some other body.

In expanding air spontaneously to a double volume, delivering it, say, into a vacuous space, it has been proved repeatedly that the air does not fall appreciably in temperature, no external work being performed; but, on the contrary, if the air at a temperature, say, of 230 deg. Fah., be expanded under pressure or resistance, as against the piston of a cylinder, giving motion to it, raising a weight, or otherwise doing work by giving motion to some other body, the temperature will fall nearly 170 deg. when the volume is doubled; that is, from 230 deg. to about 60 deg., and taking the initial pressure of 40 lbs., the final pressure would be 15 lbs. per square inch.

When a pound weight of air, in expanding at any temperature or pressure, raises 130 lbs. 1 ft. high, it loses 1 deg. in temperature; in other words, this pound of air would lose as much molecular energy as would equal the energy acquired by a weight of 1 lb. falling through a height of 130 ft. It must, however, be remarked that but a small portion of this work, 130 foot-pounds can be had as available work, as the heat which disappears does not depend on the amount of work or duty realized, but upon the total of the opposing forces, including all resistance from any external source whatever. When air is compressed, the atmosphere descends and follows the piston, assisting in the operation with its whole weight; and when air is expanded, the motion of the piston is, on the contrary, opposed by the whole weight of the atmosphere, which is again elevated. Although, therefore, in expanding air, the heat which disappears is in proportion to the total opposing force, it is much in excess of what can be rendered available; and, commonly, where air is compressed the heat generated is much greater than that which is due to the work which is required to be expended, the weight of the atmosphere assisting in the operation.

Let a pound of water, at a temperature of 212 deg. Fah., be injected into a vacuous space or vessel, having 26·36 cubic feet of capacity—the volume of 1 lb. of saturated steam at that temperature—and let it be evaporated into such steam, then 893·8 units of heat would be expended in the process. But if a second pound of water, at 212 deg., be injected and evaporated at the same temperature, under a uniform pressure of 14·7 lbs. per square inch due to the temperature, the second pound must dislodge the first, by repelling that pressure, involving an amount of labor equal to 55,800 foot-pounds (that is, 14·7 lbs. × 144 square inches × 26·36 cubic feet), and an additional expenditure of 72·3 units of heat (that is, 55,800 ÷ 772), making a total for the second pound of 965·1 units.

Similarly, when 1408 units of heat are expended in raising the temperature of air at constant pressure, 1000 of the units increase the velocity of the molecules, or produce a sensible increment of temperature; while the remaining 408 parts, which disappear as the air expands, are directly expended in repelling the external pressure.

Again, if steam be permitted to flow from a boiler into a comparatively vacuous space, without giving motion to another body, the temperature of the steam entering this space would rise much higher than that of the steam in the boiler. Or, suppose two vessels side by side, one of them vacuous, and the other filled with air at, say, two atmospheres, a communication being opened between the vessels, the pressure would become equal in the two vessels; but the temperature would fall in one vessel and rise in the other; and although the air is expanded in this manner to a double volume, there would not on the whole be any appreciable loss of heat, for if the separate portions of air be mixed together, the resulting average temperature of the whole would be very nearly the same as at first. It has been proved experimentally, corroborative of this argument, that the quantity of heat required to raise the temperature of a given weight of air to a given extent, was the same, irrespective of the density or volume of the air. Regnault and Joule found that, to raise the temperature of a pound weight of air 1 cubic foot in volume, or 10 cubic feet, the same quantity of heat was expended.

In rising against the force of gravity steam becomes colder, and partially condenses while ascending in the effort of overcoming the resistance of gravity by the conversion of heat into water. For instance, a column of steam weighing, on a square inch of base, 250·3 lbs.—that is, a pressure of 250·3 lbs. per square inch—would, at a height of 275,000 feet, be reduced to a pressure of 1 lb. per square inch, and in ascending to this height, the temperature would fall from 401 deg. to 102 deg. Fah., while at the same time, nearly 25 per cent. of the whole vapor would be precipitated in the form of water, if not supplied with heat while ascending.

If a body of compressed air be allowed to rush freely into the atmosphere, the temperature falls in the rapid part of the current by the conversion of heat into motion, but the heat is almost all reproduced when the motion is quite subsided; and from recent experiments it

appears that nearly similar results are obtained from the emission of steam under pressure.

When water falls through a gaseous atmosphere its motion is constantly retarded as it is brought into collision with the particles of that atmosphere, and by this collision it is partly heated and partly converted into vapor.

If a body of water descends freely through a height of 772 ft., it acquires from gravity a velocity of 223 ft. per second; and if suddenly brought to rest when moving with this velocity, it would be violently agitated, and raised 1 degree in temperature. But suppose a water-wheel, 772 ft. in diameter, into the buckets of which water is quietly dropped, when the water descends to the foot of the fall, and is delivered gently into the tail-race, it is not sensibly heated. The greatest amount of work it is possible to obtain from water falling from one level to another lower level is expressible by the weight of water multiplied by the height of the fall.

The object of these illustrative exhibitions of the nature and reciprocal action of heat and motive power, with their relations, are—first, to familiarize the reader with the doctrine of the mechanical equivalence of heat; second, to show that the nature and extent of the change of temperature of a gas while expanding, depends nearly altogether upon the circumstances under which the change of volume takes place.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. Faraday, D.C.L., F.R.S.

Lecture III. (Jan. 4, 1860.)—*Cohesion.—Chemical Affinity.*

We will first of all return for a few minutes to one of the experiments which we made yesterday. You remember what we put together on that occasion?—Powdered alum and warm water; here is one of those basins; nothing has been done to it since then, but you will find on examining it that it no longer contains any powder, but a multitude of beautiful crystals. Here also are the pieces of coke which I put into the other basin; these have a fine mass of crystals about them. That other basin I will leave as it is; I will not pour the water from it, because it will show you that the particles of alum have done something more than merely crystallize together. They have pushed the dirty matter from them, laying it around the outside or outer edge of the lower crystals—squeezed out, as it were, by the strong attraction which the particles of alum have for each other.

And now for another experiment. We have already gained a knowledge of the manner in which the particles of bodies—of solid bodies—attract each other, and we know that it makes calcareous spar, alum, and so forth, crystallize in these regular forms. Now, let me gradually lead your minds to a knowledge of the means we have of making this

* From the Lond. Chemical News, No. 7.

attraction alter a little in its force; either of increasing or diminishing, or apparently of destroying it altogether. I will take this piece of iron [a rod of iron about two feet long and a quarter of an inch in diameter], it has at present a great deal of strength, due to its attraction of cohesion; but if Mr. Anderson will make part of this rod hot in the fire, we shall then find that it will become soft, just as sealing-wax will when heated, and we shall also find that the more it is heated the softer it becomes. Ah! but what does *soft* mean? Why, that the attraction between the particles is so weakened that it is no longer sufficient to resist the power we bring to bear upon it. [Mr. Anderson handed to the Lecturer the iron rod, with one end red hot, which he showed could be easily twisted about with a pair of pliers.] You see, I now find no difficulty in bending this end about how I like; whereas I cannot bend the cold part at all. And you know how the smith takes a piece of iron and heats it, in order to render it soft for his purpose; he acts upon our principle of lessening the adhesion of the particles, although he does not know exactly the terms in which we express it.

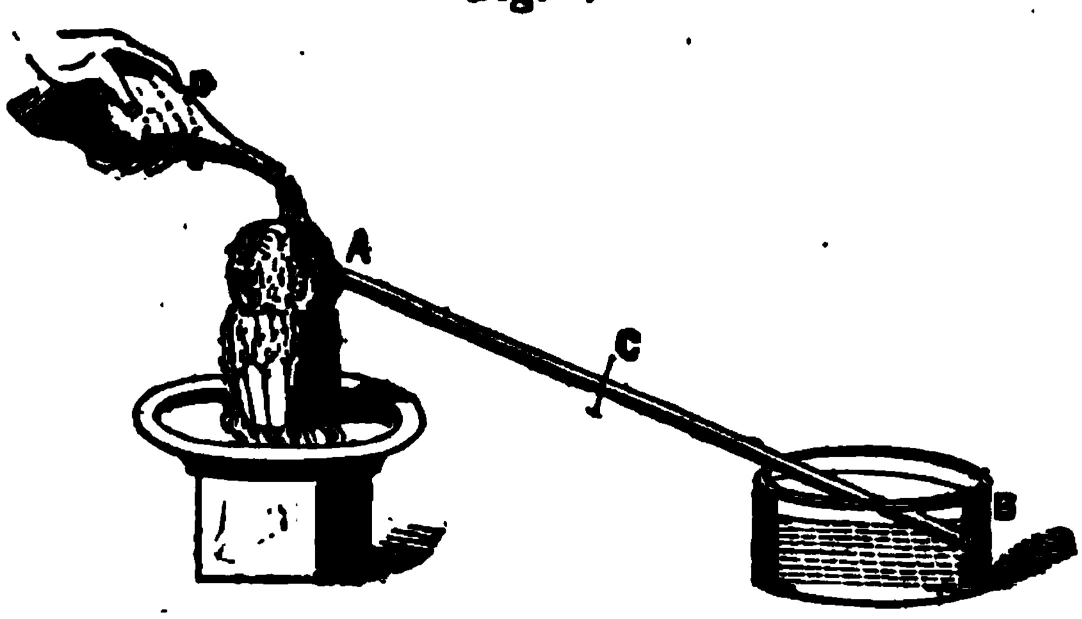
And now we have another point to examine; and this water is again a very good substance to take as an illustration (as philosophers we call it all water, even though it be in the form of ice or steam). Why is this water hard? [pointing to a block of ice] because the attraction of the particles to each other is sufficient to make them retain their place in opposition to force applied to it. But what happens when we make the ice warm? Why, in that case we diminish to such a large extent the power of attraction that the solid substance is destroyed altogether. Let me illustrate this: I will take a red-hot ball of iron [Mr. Anderson, by means of a pair of tongs, handed to the Lecturer a red-hot ball of iron, about two inches diameter] because it will serve as a convenient source of heat [placing the red-hot iron in the centre of the block of ice]. You see I am now melting the ice where the iron touches it. You see the iron sinking into it, and while part of the solid water is becoming liquid, the heat of the ball is rapidly going off. A certain part of the water is actually rising in steam—the attraction of some of the particles is so much diminished that they cannot even hold together in the liquid form, but escape as vapor. At the same time you see I cannot melt all this ice by the heat contained in this ball. In the course of a very short time I shall find it quite cold.

Here is the water which we have produced by destroying some of the attraction which existed between the particles of the ice, for below a certain temperature the particles of water increase in their mutual attraction and become ice; and above a certain temperature the attraction decreases and the water becomes steam. And exactly the same thing takes place with platinum, and nearly every substance in nature; if the temperature is increased to a certain point it becomes liquid, and a further increase makes it a gas. Is it not a glorious thing for us to look at the sea, the rivers, and so forth, and to know that this same body in the northern regions is all solid ice and ice-bergs, while here in a warmer climate it has its attraction of cohesion so much diminished

as to be liquid water? Well, in diminishing this force of attraction between the particles of ice, we made use of another force, namely, that of *heat*, and I want you now to understand that this force of heat is always concerned when water passes from the solid to the liquid state. If I melt ice in *other* ways I cannot do without heat; (for we have the means of making ice liquid without heat; that is to say, without using heat as a *direct* cause.) Suppose, for illustration, I make a vessel out of this piece of tin-foil [bending the foil up into the shape of a dish]. I am making it metallic, because I want the heat which I am about to deal with to pass readily through it;—and I am going to pour a little water on this board, and then place the tin vessel on it. Now if I put some of this ice into the metal dish, and then proceed to make it liquid by any of the various means we have at our command, it still must take the necessary quantity of heat from something, and in this case, it will take the heat from the tray, and from the water underneath, and from the other things round about. Well, a little salt added to the ice has the power of causing it to melt, and we shall very shortly see the mixture become quite fluid, and you will then find that the water beneath will be frozen—frozen because it has been forced to give up that heat which is necessary to keep it in the liquid state, to the ice on becoming liquid. I remember once, when I was a boy, hearing of a trick in a country ale-house; the point was how to melt ice in a quart pot by the fire, and freeze it to the stool. Well, the way they did it was this: they put some pounded ice in a pewter pot and added some salt to it, and the consequence was that when the salt was mixed with it, the ice in the pot melted (they did not tell me anything about the salt, and they set the pot by the fire, just to make the result more mysterious), and in a short time the pot and the stool were frozen together, as we shall very shortly find it to be the case here, and all because salt has the power of lessening the attraction between the particles of ice. Here you see the tin dish is frozen to the board, I can even lift this little stool up by it.

This experiment then cannot, I think, fail to impress upon your minds the fact, that whenever a solid body loses some of that force of

Fig. 1.



attraction by means of which it remains solid, heat is absorbed; and if, on the other hand we convert a liquid into a solid, *e.g.*, water into ice, a corresponding amount of heat is given out. I think an experi-

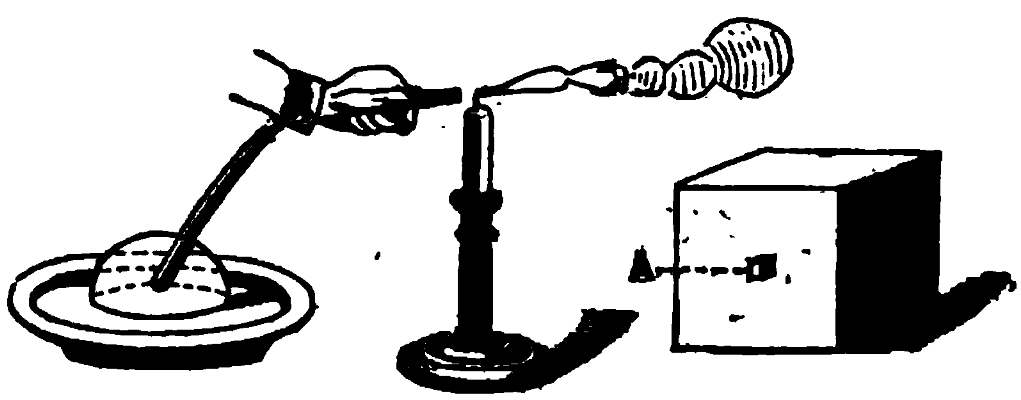
ment of this kind will serve to show you this. Here (Fig. 1) is a bulb A, filled with air, the tube from which dips into some colored liquid in the vessel B. And I dare say you know that if I put my hand on the bulb A, and warm it, the colored liquid which is now standing in the tube at C will travel forward. Now we have discovered a means, by great care and research into the properties of various bodies, of preparing a solution of a salt which if shaken or disturbed will at once become a solid; and as I explained to you just now (for what is true of water is true of every other liquid), by reason of its becoming solid, heat is evolved, and I can make this evident to you by pouring it over this bulb;—there! it is becoming solid, and look at the colored liquid, how it is being driven down the tube, and how it is bubbling out through the water at the end; and so we learn this beautiful law of our philosophy, that whenever we diminish the attraction of cohesion we absorb heat—and whenever we increase that attraction heat is evolved. This, then, is a great step in advance, for you have learned a great deal in addition to the mere circumstance that particles attract each other. But you must not now suppose that because they are liquid they have lost their attraction of cohesion; for here is the fluid mercury, and if I pour it from one vessel into another I find that it will form a stream from the bottle down to the glass—a continuous rod of fluid mercury, the particles of which have attraction sufficient to make them hold together all the way through the air down to the glass itself; and if I pour water quietly from a jug I can cause it to run in a continuous stream in the same manner. Again, let me put a little water on this piece of plate glass, and then take another plate of glass and put it on the water; there! the upper plate is quite free to move, gliding about on the lower one from side to side; and yet, if I take hold of the upper plate and lift it up straight, the cohesion is so great that the lower one is held up by it. See how it runs about it as I move the upper one, and this is all owing to the strong attraction of the particles of the water. Let me show you another experiment. Suppose I take a little soap and water—not that the soap makes the particles of the water more adhesive one for the other, but it certainly has the power of continuing in a better manner the attraction of the particles; (and let me advise you, when about to experiment with soap bubbles to take care to have every thing clean and soapy.) I will now blow a bubble, and that I may be able to talk and blow a bubble too, I will take a plate with a little of the soap-suds in it, and will just soap the edges of the pipe, and blow a bubble on to the plate. Now, there is our bubble. Why does it hold together in this manner? Why, because the water of which it is composed has an attraction of particle for particle:—so great, indeed, that it gives to this bubble the very power of an india-rubber ball; for you see, if I introduce one end of this glass tube into the bubble that it has the power of contracting so powerfully as to force enough air through the tube to blow out a light (Fig. 2)—there is a light blown out. And look! see how the bubble is disappearing; see how it is getting smaller and smaller.

There are twenty other experiments I might show you to illustrate

this power of the cohesion of the particles of liquids. For instance, what would you propose to me, if, having lost the stopper out of this alcohol bottle, I should want to close it speedily with something near at hand. Well, a bit of paper would not do, but a piece of linen cloth would, or some of this cotton wool which I have here. I will put a tuft of it into the neck of the alcohol bottle, and you see when I turn it upside down, that it is perfectly well stoppered so far as the alcohol is concerned; the air can pass through but the alcohol cannot. And if I were to take an oil vessel this plan would do equally well, for in former times they used to send us oil from Italy in flasks stoppered only with cotton wool (at the present time the cotton is put in after the oil has arrived here, but formerly it used to be sent so stoppered). Now if it were not for the particles of liquid cohering together, this alcohol would run out, and if I had time I could have shown you a vessel with the top, bottom, and sides altogether formed like a sieve, and yet it would hold water owing to this cohesion.

You have now seen that the solid water can become fluid by the addition of heat, owing to this lessening the attractive force between its particles, and yet you see that there is a good deal of attractive force remaining behind. I want now to take you a step beyond that. We

Fig. 2. Fig. 3.



saw that if we continued applying heat to the water (as indeed happened with our piece of ice here) that we did at last break up that attraction which holds the liquid together, and I am going to take some ether (any other liquid would do, but ether makes a better experiment for my purpose) in order to illustrate what will happen when this cohesion is broken up. Now this liquid ether, if exposed to a very low temperature, will become a solid, but if we apply heat to it, it becomes vapor, and I want to show you the enormous bulk of the substance in this new form:—when we make ice into water, we lessen its bulk, but when we convert water into steam, we increase it to an enormous extent. You see it is very clear that as I apply heat to the liquid I diminish its attraction of cohesion—it is now boiling, and I will set fire to the vapor, so that you may be enabled to judge of the space occupied by the ether in this form by the size of its flame, and you now see what an enormously bulky flame I get from that small volume of ether below. The heat from the spirit lamp is now being consumed, not in making the ether any warmer, but in converting it into vapor, and if I desired to catch this vapor and condense it (as I could without much difficulty), I would have to do the same as if I wished to convert steam into water and water into ice; in either case it would be neces-

sary to increase the attraction of the particles, by cold or otherwise. So largely is the bulk occupied by the particles increased by giving them this diminished attraction, that if I were to take a portion of water a cubic inch in bulk (A Fig. 3) I should produce a volume of steam of that size B [1700 cubic inches; nearly a cubic foot], so greatly is the attraction of cohesion diminished by heat; and yet it still remains water. You can easily imagine the consequences which are due to this change in volume by heat—the mighty powers of steam and the tremendous explosions which are sometimes produced by this force of water. I want you now to see another experiment which will perhaps give you a better illustration of the bulk occupied by a body when in the state of vapor. Here is a substance which we call iodine, and I am about to submit this solid body to the same kind of condition as regards heat that I did the water and the ether [putting a few grains of iodine into a hot glass globe, which immediately became filled with the violet vapor], and you see the same kind of change produced. Moreover, it gives us the opportunity of observing how beautiful is the violet-colored vapor from this black substance, or rather the mixture of the vapor with air (for I would not wish you to understand that this globe is entirely filled with the vapor of iodine).

If I had taken mercury and converted it into vapor (as I could easily do), I should have a perfectly colorless vapor, for you must understand this about vapors, that bodies in what we call the vaporous or gaseous state, are always perfectly transparent, never cloudy or smoky; they are, however, often colored, and we can frequently have colored vapors or gases produced by colorless particles themselves mixing together, as in this case [the Lecturer here inverted a glass cylinder full of binoxide of nitrogen over a cylinder of oxygen, when the dark red vapor of hyponitric acid was produced]. Here also you see a very excellent illustration of the effect of some power of nature which we have not yet come to, but which stands next on our list—CHEMICAL AFFINITY. And thus you see we can have a violet vapor or an orange vapor, and different other kinds of vapor, but they are always perfectly transparent, or else they would cease to be vapors.

I am now going to lead you a step beyond this consideration of the attraction of the particles for each other. You see we have come to understand that (to take water as an illustration) whether it be ice, or water, or steam, it is always to be considered by us as water. Well, now prepare your minds to go a little deeper into the subject. We have means of searching into the constitution of water beyond any that are afforded us by the action of heat, and among these one of the most important is that force which we call voltaic electricity, which we used at our last meeting for the purpose of obtaining light, and which we carried about the room by means of these wires. This force is produced by the battery behind me, to which, however, I will not now refer more particularly; before we have done we shall know more about this battery, but it must grow up in our knowledge. Now here (Fig. 4) is a portion of water in this little vessel C, and besides the water there are two plates of the metal platinum, which are connected with

the wires A B, coming outside, and I want to examine that water, and the state and the condition in which its particles are arranged. If I were to apply heat to it you know what we should get, it would assume

Fig. 4.

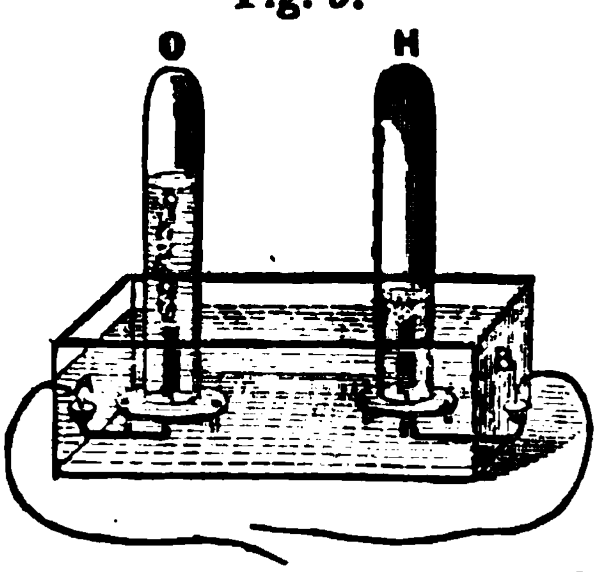
the state of vapor, but it would nevertheless remain water, and would return to the liquid state as soon as the heat was removed. Now by means of these wires (which are connected with the battery behind me, and come under the floor and up through the table) we shall have a certain amount of this new power at our disposal. Here you see it is [causing the ends of the wires to touch]—that is the electric light we used yesterday, and by means of these wires we can cause water to submit itself to this power; for the moment I put them into metallic connexion at A and B, you see the water boiling in that little vessel C, and you hear the bubbling of the gas that is going through the tube D. See how I am converting the water into vapor, and if I take a little vessel E, and fill it with water, and put it in the trough over the end of the tube D, there goes the vapor ascending into the vessel. And yet that is not steam, for you know that if steam is brought near cold water, it would at once condense, and return back again to water; this, then, cannot be steam, for it is bubbling through the cold water in this trough, but it is a vaporous substance, and we must therefore examine it carefully, to see in what way the water has been changed. And now, in order to give you a proof that it is not steam, I am going to show you that it is combustible, for if I take this small vessel to a light, the vapor inside explodes in a manner that steam could never do.

I will now fill this large bell-jar F with water; and I propose letting the gas ascend into it, and I will then show you that we can reproduce the water back again from the vapor or air that is there. Here is a strong glass vessel G, and into it we will let the gas from F pass. We will then fire it by the electric spark, and then after the explosion you will find that we have got the water back again; it will not be much, however, for you will recollect that I showed you how small a portion of water produced a very large volume of vapor. Mr. Anderson will now pump all the air out of this vessel G, and when I have screwed it on to the top of our jar of gas F, you will see upon opening the stop-cocks H′ H H, the water will jump up, showing that some of the gas has

passed into the glass vessel. I will now shut these stop-cocks, and we shall be able to send the electric spark through the gas by means of the wires I K in the upper part of the vessel, and you will see it burn with a most intense flash. [Mr. Anderson here brought a Leyden jar, which he discharged through the confined gas by means of the wires I K.] You saw the flash, and now, that you may see that there is no longer any gas remaining, if I place it over the jar and open the stop-cocks again, up will go the gas, and we can have a second combustion; and so I might go on again and again, and I should continue to accumulate more and more of the water to which the gas has returned. Now is not this curious;—in this vessel C we can go on making from water a large bulk of *permanent gas*, as we call it, and then we can reconvert it into water in this way. [Mr. Anderson brought in another Leyden jar, which, however, from some cause would not ignite the gas. It was therefore recharged, when the explosion took place in the desired manner.] How beautifully we get our results when we are right in our proceedings!—it is not that Nature is wrong when we make a mistake. Now I will lay this vessel G down by my right hand, and you can examine it by-and-by; there is not very much water flowing down, but there is quite sufficient for you to see.

Another wonderful thing about this mode of changing the condition of the water is this—that we are able to get the separate parts of which it is composed, at a distance the one from the other, and to examine them, and see what they are like, and how many of them there are; and for this purpose I have here some more water in a slightly different apparatus to the former one (Fig. 5), and if I place this in connexion with the wires of the battery at A B, I shall get a similar decomposition of the water at the two platinum plates. Now I will put this little tube O over there, and that will collect the gas together that comes from the side A, and this tube H will collect the gas that comes from the other side B, and I think we shall soon be able to see a difference. In this apparatus the wires are a good way apart from each other, and it now seems that *each* of them is capable of drawing off particles from the water and sending them off, and you see that one set of particles, H, is coming off twice as fast as those collected in the other tube O. Something is coming out of the water *there* at H which burns [setting fire to the gas], but what comes out of the water *here* at O, although it will not burn, will support combustion very vigorously [the Lecturer here placed a match with a glowing tip in the gas, when it immediately rekindled].

Fig. 5.

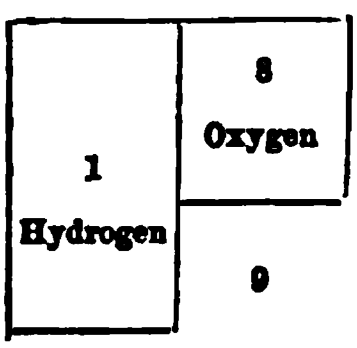


Here, then, we have two things, neither of them being water alone, but which we get out of the water. Water is therefore composed of two substances different to itself, which appear at separate places when it is made to submit to the force which I have in these wires, and if I take an inverted tube of water and collect this gas, H, you will

see that it is by no means the same as the one we collected in the former apparatus (Fig. 4). That exploded with a loud noise when it was lighted, but this will burn quite noiselessly—it is called *hydrogen;* and the other we call *oxygen*—that gas which so beautifully brightens up all combustion but does not burn of itself. So now we see that water consists of two kinds of particles attracting each other in a very different manner to the attraction of gravitation or cohesion, and this new attraction we call *chemical affinity*, or the force of chemical action between different bodies; we are now no longer concerned with the attraction of iron for iron, water for water, wood for wood, or like bodies for each other, as we were when dealing with the force of cohesion; we are dealing with another kind of attraction,—the attraction between particles of a *different* nature one to the other. Chemical affinity depends entirely upon the energy with which particles of *different* kinds attract each other. Oxygen and hydrogen are particles of different kinds, and it is their attraction to each other which makes them chemically combine and produce water.

I must now show you a little more at large what chemical affinity is. I can prepare these gases from other substances as well as from water; and we will now prepare some oxygen: here is another substance which contains oxygen—chlorate of potash; I will put some of it into this glass retort, and Mr. Anderson will apply heat to it; we have here different jars filled with water, and when by the application of heat the chlorate of potash is decomposed, we will displace the water, and fill the jars with gas.

Now when water is opened out in this way by means of the battery; which adds nothing to it materially, which takes nothing from it materially (I mean no *matter*, I am not speaking of *force*), which adds no *matter* to the water; it is changed in this way—the gas which you saw burning a little while ago, called *hydrogen*, is evolved in large quantity, and the other gas, *oxygen*, is evolved in only half the quantity,



Oxygen, . . .	88·9
Hydrogen, . . .	11·1
Water, . . .	100·0

so that those two areas represent water, and those are always the proportions between the two gases. But oxygen is sixteen times the weight of the other—eight times as heavy as the particles of hydrogen in the water; and you therefore know that water is composed of nine parts by weight—one of hydrogen and eight of oxygen, thus:

Hydrogen, . .		46·2 cub. ins. . .	= 1 grain.
Oxygen, . .		23·1 " .	= 8 "
Water, .	(*steam*)	69·3 " . .	= 9 "

Now Mr. Anderson has prepared some oxygen, and we will proceed to examine what is the character of this gas. First of all, you remember I told you that it does not burn, but that it affects the burning of

other bodies. I will just set fire to the point of this little bit of wood, and then plunge it into the jar of oxygen, and you will see what this gas does in increasing the brilliancy of the combustion. It does not burn, it does not take fire as the hydrogen would, but how vividly the combustion of the match goes on. Again, if I were to take this wax taper and light it, and turn it upside down in the air, it would, in all probability put itself out, owing to the wax running down into the wick [the Lecturer here turned the lighted taper upside down, when in a few seconds it went out]. Now that will not happen in oxygen gas; you will see how differently it acts (Fig. 6) [the taper was again lighted, turned upside down, and then introduced into a jar of oxygen]. Look at that! see how the very wax itself burns, and falls down in a dazzling stream of fire, so powerfully does the oxygen support combustion. Again, here is another experiment which will serve to illustrate the force, if I may so call it, of oxygen. I have here a circular flame of spirit of wine, and with it I am about to show you the way in which iron burns, because it will serve very well as a comparison between the effect produced by air and oxygen. If I take this ring flame, I can shake, by means of a sieve, the fine particles of iron filings through it, and you will see the way in which they burn [the Lecturer here shook through the flame some iron filings, which took fire and fell through with beautiful scintillations]. But if I now hold the flame over a jar of oxygen [the experiment was repeated over a jar of oxygen, when the combustion of the filings as they fell into the oxygen became almost insupportably brilliant], you see how wonderfully different the effect is in the jar, because there we have oxygen instead of common air.

(To be Continued.)

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*On the Influence of White Light, of the different Colored Rays, and of Darkness, on the Development, Growth, and Nutrition of Animals.** By Horace Dobell, M. D., &c.

The apparatus used in the following experiments was described in my Paper; but in the present instance, only two of the cells were employed, viz: that exposed to ordinary white light, and that from which all light is excluded. In order more effectually to prevent the possible admission of light, the following precautions were adopted with the dark cell:—1. The perforated zinc floor was covered with thick brown paper. 2. The under surface of the lid was lined with black cloth, to secure accurate adjustment when shut. 3. The opaque black glass was covered with an additional coat of black oil-paint. 4. The lid was never opened in any light except that of a candle or of gas.

March 20th, 1859.—A number of ova of the silk-worm (*Bombyx mori*), all of the same age, were placed in each of the two cells. No

* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

change was observed until *May* 18*th* (sixty days after the commencement of the experiments), when one larva emerged from the ovum in each cell; and during twelve days, larvæ continued to emerge in the light and in the dark at the same rate.

June 9*th*.—Sixteen larvæ, as nearly as possible of the same size, were selected in each cell, and the rest removed. The experiments then proceeded with these thirty-two individuals, and no death occurred from first to last.

The following Table shows the day on which each larva began to spin; the day on which the perfect insect escaped from the pupa; and hence the number of days occupied by the metamorphosis.

Light.			Darkness.		
Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.	Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.
July 1	July 18	18 days inclusive	June 30	July 18	19 days inclusive.
" 2	" 19	18 " "	" 30	" 18	19 " "
" 2	" 19	18 " "	" 30	" 18	19 " "
" 2	" 18	17 " "	" 30	" 18	19 " "
" 2	" 18	17 " "	" 30	" 21	22 " "
" 2	" 19	18 " "	July 1	" 18	18 " "
" 2	" 19	18 " "	" 1	" 18	18 " "
" 3	" 19	17 " "	" 2	" 18	17 " "
" 3	" 21	19 " "	" 2	" 19	18 " "
" 4	" 20	17 " "	" 2	" 20	19 " "
" 4	" 20	17 " "	" 2	" 19	18 " "
" 4	" 20	17 " "	" 2	" 20	19 " "
" 4	" 21	18 " "	" 2	" 21	20 " "
" 4	" 21	18 " "	" 3	" 21	19 " "
" 5	" 21	17 " "	" 3	" 20	18 " "
" 6	" 24	19 " "	" 4	" 21	18 " "

From this it is seen that the mean period occupied by the metamorphosis in the *darkened cell* was eighteen days fifteen hours, and in the *light cell* seventeen days sixteen hours.

The longest and shortest periods in the *darkened cell*, twenty-two days and seventeen days, in the *light cell*, nineteen days and seventeen days.

June 9*th*.—On selection of sixteen of the largest larvæ from the inhabitants of each cell, it was noted that, when sixteen were selected from the *darkened cell* and several of *similar size* removed, only four could be found as large in the *white cell;* the remaining twelve selected were therefore of a rather smaller size. This difference in the two cells became less obvious afterwards, but, throughout the experiments, there was a slight difference of size in favor of the darkened cell.

With these exceptions, no difference could be detected between the results obtained in the cell from which light was completely excluded and in that exposed to its full influence.

The larvæ, the silk produced, and the moths from the two cells, when placed side by side, could not be distinguished from one another. The ova were of the same color when first deposited, and under-

went the same changes of appearance, at the same time, in the dark and in the light.

So far, therefore, as the direct agency of light is concerned in the development, growth, nutrition, and coloration of animals, the results of these experiments closely correspond with those already recorded in my Paper.—*Phil. Mag.* s. 4. vol. xviii, p. 143.

For the Journal of the Franklin Institute.

Observations on the Eclipse of July 17th, 1860.

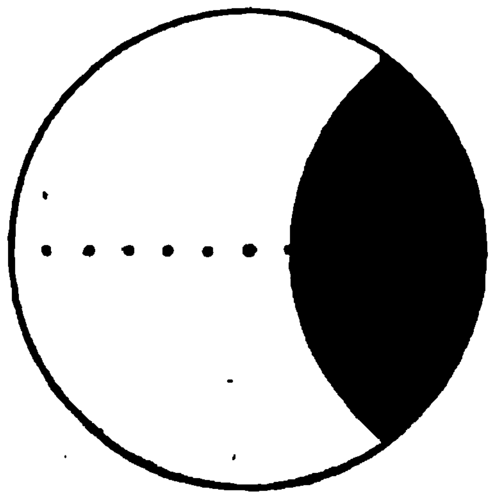
The following observations of the eclipse of the sun, July 17, 1860, were made at Germantown, Penna. Lat. of observatory, 40° 1′ 39″, Long. 5° 0′ 41·9″.

The instrument used was a good refractor, and the time is that shown by an astronomical clock regulated by a transit instrument.

The morning was clear, and in every respect favorable to observation.

Time of first contact,	19^h	5^m	00^s	Thermom. in sun,		96°
Greatest obscuration,	20	4	18·5	"	"	89
End of eclipse,	21	3	37	"	"	106·5

The mean height of the thermometer in the sun during the eclipse, was 101·25°, which point, it is fair to suppose, it would have reached at 20 h. 4 m. 18·5 s. under ordinary circumstances, and therefore that a modification of temperature of 12·25° was produced by the interception of the sun's rays at the middle of the eclipse.



The figure, which is taken from a drawing of the image thrown upon the ground glass of a camera obscura at the time of greatest obscuration, shows five digits eclipsed.

N. B. It may not be amiss in this connexion to make some allusion to the very extraordinary atmospheric phenomenon of Friday evening, the 20th inst.

About 9½ o'clock, P. M., a luminous body nearly the size of the full moon when setting, appeared in the western heavens, at an elevation of about 25°, shedding a brilliant light upon all terrestrial objects. It moved with moderate velocity in a north-easterly direction, preserving its parallelism with the horizon almost throughout its course, upon reaching the centre of which it divided, without any perceptible report however, into several lesser bodies, following each other at short intervals, gradually diminishing and leaving sparks in their train, until lost in the east in one single bright star, about the diameter of the planet Mars, as it now appears.

It is not a little remarkable that, notwithstanding the large number of persons who witnessed this phenomenon, singular coincidence prevailed in their impressions with regard to its magnitude, velocity, duration, &c.: thus contradicting the common assertion that no two men see the same thing alike. W.

Germantown.

*Description of a Patent Blast Gas Furnace.** By J. J. Griffin, F.C.S.

(Continued from page 101.)

Gas Furnace heated at the bottom.—In this furnace the parts are the same as those marked *a*, *b*, *c*, *d*, *e*, *e*, in Fig. 2; but the gas-burner is in this case put into the bottom of the furnace instead of the top, and the arrangement of the crucible and its support is altered. Upon the centre of the clay plate *d*, the perforated plumbago cylinder and cover, Nos. 5 and 7 are placed; and upon them a plumbago crucible, No. 10. The size of the crucible, and the height of the perforated cylinder, are to be so adjusted that the bottom of the crucible shall be struck by the hottest part of the gas flame; that is to say, the space left between the face of the gas-burner and the bottom of the crucible must not exceed 2½ inches. The crucible is provided with a closely fitting cover, and pebbles are then filled in between the crucible jacket and the furnace cylinder, and are covered over the crucible until both the pieces of the furnace *e e*, are filled. The gas is then lighted, the blast of air is set on, the gas-burner is forced up into the hole in the clay plate *d*, and the operation proceeds. In from ten to twenty minutes after the gas is lighted—this difference of time depending upon the size of the furnace, and the weight of the metal contained in the crucible—the interior of the lower cylinder *e*, acquires a white heat. The progress of the operation can be watched by occasionally removing the stone peg in the trial-hole of the furnace cylinder *e*. The heat very slowly ascends into the upper cylinder, and it never becomes so great in the upper as in the lower cylinder. The greatest fusing power of the furnace is confined within a vertical space of about six inches, reckoning from the bottom. The power of flint pebbles to abstract heat from the gases which pass through this apparatus is quite remarkable. When about six inches of pebbles lie above the crucible, and the crucible and the pebbles about it have been white hot for half an hour, the hand can be held over the top of the furnace, within a few inches of the pebbles, without inconvenience. It becomes wetted with the vapor which rises from the furnace, but feels only a moderate degree of heat.

This form of the furnace is attended by the inconvenience that you cannot examine the condition of the matter contained in the crucible, to ascertain when the heat has been continued long enough. In cases where the fusion is performed repeatedly on the same weight of metal, this would be of no importance, because the power of the furnace is so steady and regular, that the time of firing which has been found to answer once will answer the same purpose again.

When it is supposed that the fusion of the metal submitted to trial is completed, the gas is first to be turned off, and then the supply of air stopped. You can either allow the furnace to remain intact till it is cold, or lift off the cylinders *e e*, with tongs, and allow the hot stones to fall into the iron pan placed below the furnace to receive them. A

* From the Lond. Chemical News, No. 4.

few bricks should be laid between the pan and the table or stool on which it rests, if the latter is made of wood; because the heat given off by the pebbles is very great. The pebbles being raked away from the crucible, the contents of the latter can be examined.

The absolute sizes of the furnaces depend upon the amount of work required from them. The fusions described below were mostly made in a furnace of six inches internal diameter, a few in a furnace of four inches internal diameter, and one or two in a furnace of eight inches internal diameter; all of them with a gas-burner of sixteen holes, and a supply of gas obtained from a half-inch pipe. A large furnace with an internal diameter of twelve inches, will demand a gas-burner of twenty-six holes, and a supply of gas from a pipe of nearly one inch in the bore.

Examples of Fusions effected by the Blast Gas Furnace.—The fusing points of certain metals have been fixed by Daniell at the following temperatures:—

Silver,	1873° F.	Copper,	1996° F.
Gold,	2016°	Cast Iron,	2786°

Brass, with 25 per cent. of zinc, at 1750° F.

All these metals melt readily in the gas furnace. Quantities of 3 lbs. of copper or cast iron can be completely fused in fifteen minutes in a six-inch furnace. Quantities of 8 or 10 lbs. of copper or cast iron can be completely fused into a homogeneous mass in a six-inch or eight-inch furnace within one hour, using a sixteen-hole burner, and a supply of gas from a half-inch pipe.

In a furnace of the same size I have fused 45 ounces of nickel, and in other experiments I have produced masses of wrought iron weighing 18 ounces, 28 ounces, 40 ounces. The piece of 18 ounces was perfectly fused. The piece of 30 ounces was not quite fused, the crucible having melted, and stopped the operation. I have also fused cobalt, and reduced it to the metallic state from the peroxide by ignition with charcoal. The time required for the fusion of these refractory metals is from one and a half to two hours.

Scraps of platinum can be fused into a porous mass, but not into a solid homogeneous bead. I have mentioned that thin platinum wires fuse readily in the free flame of the gas-jet produced by the burner (Fig. 1); but when the jet plays upon a quantity of the metal contained in a crucible the relations of power and effect are different.

When the metals to be melted are such as do not undergo oxidation, the method of action represented by Fig. 2 is most convenient. In this manner gold can be readily melted, and by removing the gas-burner the melted metal can be stirred. When the action of oxygen is to be avoided, the crucible must have a cover, which in some cases should be securely luted to it.

Choice of Crucibles.—The experiments above referred to were made with coal gas at the ordinary pressure, and with a blast of cold atmospheric air. Greater effects can be produced by the use of oxygen gas, or of heated atmospheric air. But a difficulty stands in the way of the use of these greater degrees of heat in the want of crucibles capable of enduring their action.

With cold atmospheric air, pure nickel and pure iron dissolve every kind of siliceous crucible, and it is, therefore, needless to heat the air or to prepare oxygen till a superior kind of crucible is obtainable. At present, these metals can only be melted in plumbago crucibles, which necessarily communicate to them more or less carbon.

Metals which melt at moderate degrees of heat, such as gold and copper, are easily fused either in clay crucibles, or in those of plumbago; the latter, be it remembered, being a mixture of graphite and clay. Metals in combination with carbon, such as cast iron, also melt readily in clay crucibles, without destroying them. But when such metals as iron, nickel, and cobalt, are freed from carbon, and brought into a state of purity, they acquire an extraordinary attraction for silica at a white heat, so that the metal and the silica readily run down into a very fusible silicate. Even when plumbago crucibles are used, the carbon burns away at some particular point, the metal then attacks the clay, bores a hole through the crucible, and finishes the operation. No kind of clay or porcelain will withstand the action of pure iron or nickel at a white heat. It is therefore impossible to effect any large fusions of these metals when they are free from carbon, or when they are heated in crucibles that are free from carbon.

Fusion of Metals in large quantities, and Ignition of Objects of large size.—As the gas-burner, Fig. 1, can be held in any required position, it is possible to apply heat to large objects by using several gas-burners. Thus, a large crucible may be fixed in a square furnace, and gas-burners be applied below and on the four sides of the furnace; the spaces between the crucible and the walls of the furnace being filled with pebbles, to collect the heat and apply it to all parts of the crucible.

Muffle Furnace for Assaying, Roasting, &c.—A muffle, placed in an assay furnace, and built up with pebbles, can be heated either from above or from below by the blast gas-burner. The flame and products of combustion can be made to sweep through the muffle, whether going upwards or downwards. The *air* pipe and *gas* pipe attached to the gas-burner, Fig. 1, must each be provided with a stop-cock. When the front door of the muffle is opened to afford the opportunity for examining the cupels, the blast, if continued, would blow out there against the operator; but that occurrence is prevented by turning the stop-cocks. When it is desired to oxidize the substances in the muffle, the furnace is first brought up to a sufficient temperature, and then the gas is turned off, but the blast of air is continued. The air passing through the hot pebbles enters the muffle at a high temperature, and not exhausted of oxygen, because there is no carbonaceous matter present among the pebbles when the gas is turned off. The pure and highly heated air is consequently in a proper condition for oxidizing metals that are already raised to a red heat in the muffle. The same apparatus is useful where substances require to be roasted in the presence of air, in order to oxidize and expel some volatile ingredient. We have in this process an effectual means of using hot air to aid the process of cupellation.

Distillation per Descensum.—Suppose a stoneware bottle with a long neck to be fitted with a stoneware tube, passing nearly to the bottom of the bottle, and projecting some inches beyond its mouth. Suppose this bottle to be half filled with metallic zinc, and then to be fixed upside down in the furnace, Fig. 2, with the tube projecting downwards through the hole in the plate *d*, and nearly dipping into a vessel of water. The furnace being packed with pebbles, and the heat applied at the top, the distillation of zinc *per descensum* then takes place.

Miscellaneous Uses of the Blast Gas Furnace.—1. The preparation of chemical substances by the projection of mixtures into a crucible kept at a red or a white heat. 2. For melting silver, gold, copper, cast iron, brass, bronze, nickel-silver, &c., either for making small castings or ingots. 3. For experiments on glass; every description of which it is able to fuse. 4. For experiments on enamel, colored glasses, and artificial gems. 5. For experiments on metallic alloys. 6. For the fusion of steel. 7. For the use of dentists, in the preparation of mineral artificial teeth. 8. For the assay of ores of silver, copper, lead, tin, iron, and other metals. 9. For all purposes of ignition, combustion, fusion, or dry distillation, at a red heat, or a white heat, where it is desirable to produce those temperatures promptly, certainly, steadily, conveniently, and cheaply.

Exhibition of Colored Flames.—When the gas-burner, Fig. 1, is supplied with gas and air, and is inflamed in the open air, so as to produce a clear blue flame of 3 inches long, and beyond it a flickering, nearly colorless flame of 12 inches long, brilliant colors may be given to this flame by the introduction of concentrated solutions of certain salts. A ball of pumice-stone, 2 inches in diameter, fastened to a stout iron wire, is dipped into the saline solution, and while wet is plunged into the flame, upon which the whole flame becomes colored. Solutions of the following salts may be used for these experiments:—

1. *Chloride of Strontium* gives a brilliant crimson flame. 2. *Chloride of Calcium*, a reddish orange flame. 3. *Chloride of Sodium*, brilliant yellow. 4. *Chloride of Copper*, blueish green. If the flame is touched on one side with the copper solution, and on the other with the strontium solution, half the flame is green and half crimson. The colors and reflections of these flames are necessarily most brilliant in a dark room. A remarkable effect is produced by the yellow soda flame. It is reflected from the human countenance with a ghastly blackness.

Repair of the Gas Furnace.—When the clay cylinders become warped or chipped, so as to allow the gases to escape at the joints laterally, they must be luted for each operation by applying a little wet fire-clay by means of a spatula. When only a moderate heat is required, this luting is unnecessary.

The Patent Blast Gas Furnace is capable of melting so many of the refractory metals, and in quantities that are so well adapted for the usual analytical experiments of chemists and assayers, as almost to supersede the use of fixed wind furnaces and portable blast furnaces, fed by charcoal or coke.

For the Journal of the Franklin Institute.

Notes on the Evaporative Efficiency of "Japanese Coals" for Steaming Purposes. By Wm. H. Shock, Chief Engineer U. S. Navy.

In obedience to an order of the late Commander-in-chief of the East India Squadron to furnish him with a statement of the comparative value of the Japanese coals for steaming purposes with that of other coals used in the Navy, I availed myself for this purpose of copies of the steam logs and engine diagrams of the frigates *Minnesota* and *Mississippi*, which were kindly furnished by their respective chief engineers, for the period in which they used the coals; and with the data in my own possession of the *Powhatan* whilst using the same coals, the following record of results was deduced:

It is proper to state that the coals were received on board the ships and expended in the usual manner, without any reference whatever to a special report. This fact establishes the *practical* value of the results.

Particulars of the Ships.—The *Minnesota* is a screw frigate 3200 tons. Two trunk engines, direct-acting. Working area of each piston, 4071·5 sq. ins. Stroke of pistons, 36 ins. Supplied by 4 multitubular boilers, Martin's patent. Heating surface, 11,500 sq. ft. Space displacement of piston for one revolution of one engine, 169·60 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 9·90 cubic feet. Total capacity for steam in one engine for one revolution, 179·50 cubic feet.

The *Mississippi* is a side-wheel steamer of the first class, 1692 tons. Two side-lever engines. Diameter of cylinder, 75·5 ins. Stroke of piston, 7 ft. Supplied with 2 multitubular boilers, Martin's patent. Heating surface, 7676 sq. feet. Space displacement of piston for one revolution of one engine, 435·20 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 21·52 cubic feet. Total capacity for steam in one engine for one revolution, 456·72 cub. ft.

The *Powhatan* is a side-wheel steamer of the first class, 2415 tons. Two inclined engines. Diameter of cylinder, 70 ins. Stroke of piston, 10 ft. Supplied with 4 copper boilers, double upper return flues. Heating surface, 8100·59 sq. ft. Space displacement of piston for one revolution of one engine, 534·50 cub. ft. Space included in nozzles, clearance, &c., at both ends of one cylinder, 26·00 cub. ft. Total capacity for steam in one engine for one revolution, 560·50 cub. ft.

Localities of the Mines and their mode of working them.—There are without doubt vast coal fields interspersed throughout the Japanese Empire, unknown even to the Japanese themselves. But of those known and worked, I have examined specimens from three, viz:—From one near Hakodadi on the island of Yesso, in the northern part of Japan; a second from Sikuzen on the island of Kiusiu (110 miles from Nagasaki); and the third from a mine in the province Satzuma, near Nagasaki: all presenting nearly the same characteristics.

I have never been permitted at any time to visit the mines. They

persistently objected to foreigners inspecting them; but from the most reliable authority I learned that they are worked without the aid of machinery, both coal and water being brought out on the backs of coolies in buckets; and the working of an opening is quickly suspended when the labor necessary to keep down the water exceeds that required to bring away the coals, which soon occurs after getting below the surface, particularly in a country abounding in springs, as does Japan. The result is that old openings are abandoned before they are worked sufficiently deep to secure good coals, and hence it rarely if ever occurs that any but outcroppings and surface coals reach market.

Description of the Coals.—Their Furnace Phenomena.—The coals are bituminous. Cohesion weak. Mechanical structure, lamellar. Fractures exhibit a dull black in all their partings. 37 cub. ft. displace one ton. In the furnace it kindles easily and burns freely with a bright flame, emitting immense volumes of densely black smoke. Intumesces slightly, and occasionally I found traces of iron pyrites present in minute quantities.

Residuum—Large quantities of spongy clinker (from 27 to 30 per cent. by weight) which cake on the bars but are readily removed. The per centum of clinker by *weight* conveys no idea of its ***bulk***, as it must have reached in many cases the enormous proportion of 50 per cent.! The proportion of ashes produced was unusually small.

Data and Results deduced therefrom.

Copy Minnesota's *Steam Log.* Capt. S. F. Dupont *Commanding. At sea, September 1st,* 1858.

Hour. A. M.	Speed. K.	Speed. F.	Course.	Wind. Direc.	Wind. Force.	Revolution of Engine.	Pressure of Steam.	Vacuum. A.	Vacuum. F.	Throttle.	Coal	Ashes.	Sat. of Boilers. 1	2	3	4	Temperature. Engine Room.	Hot-well. A.	Hot-well. F.	6·714 lbs. Mean Terminal Pressure of the Day's Diagrams.
1	7	4	W S W.	SE by S.	4	33·1	7	19	23	[illegible]	2640		[illegible]	2	[illegible]	[illegible]	106	104	104	
2	7	4	"	S.	4	31·6	5	19	22	[illegible]	4200		[illegible]	[illegible]	[illegible]	[illegible]	104	102	103	
3	0	4	W by S.	"	4	35·1	8	19	22	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	104	102	102	
4	10	4	"	"	5	36·5	12	20	22	[illegible]		30	[illegible]	[illegible]	[illegible]	[illegible]	104	104	104	
5	6	4	W S W.	S. by E.	6	26·5	12	19	21	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	106	98	97	
6	7	4	W by S.	"	5	29·8	8	19½	22	1			[illegible]	[illegible]	[illegible]	[illegible]	106	98	97	
7	7	4	"	"	4	31·6	10	20	22	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	106	98	97	
8	7	2	"	S S E.	4	33·7	11	20½	22	[illegible]		43	1	[illegible]	[illegible]	[illegible]	106	100	100	
9	8	2	"	"	4	35·6	9	19½	22	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	106	98	98	
10	7	4	"	"	5	32·1	7	19½	22	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	101	97	97	
11	7	2	"	"	5	31·	6	19½	22	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	103	97	97	
12	7	6	"	E.	4	39·5	10	19½	22	[illegible]		08	[illegible]	[illegible]	[illegible]	[illegible]	101	97	97	
Expended, 105,600 Japan Coals.						Revolutions made, 46,865.								Knots run, 169·4						
P.M.																				
1	10	4	W ½ S.	N E.	4	39·	10	23½	24	[illegible]	3640		[illegible]	[illegible]	[illegible]	[illegible]	101	98	99	
2	11	6	"	N.	5	39·	10	23	23	[illegible]	3220		[illegible]	[illegible]	[illegible]	[illegible]	102	98	98	
3	5–4	6	W by S.	N by W.	6	40·	13	23½	23	[illegible]	7980		[illegible]	[illegible]	[illegible]	[illegible]	102	98	100	
4	4–6		"	"	10	33·	9	23½	23	[illegible]	4900	5750	[illegible]	[illegible]	[illegible]	[illegible]	102	98	100	
5	7	4	"	"	9	33·1	10	23½	22½	[illegible]	4000		[illegible]	[illegible]	[illegible]	[illegible]	106	98	101	
6	7	4	W.	"	8	29·3	8	24	22½	[illegible]	3300		[illegible]	[illegible]	[illegible]	[illegible]	106	98	101	
7	6	4	"	"	6	33·0	12	24	23	[illegible]	4620		[illegible]	[illegible]	[illegible]	[illegible]	96	95	96	
8	6	4	"	"	6	33·8	10	24½	23	[illegible]	7000	13312	[illegible]	[illegible]	[illegible]	[illegible]	96	96	97	
9	5	4	"	"	7	31·6	9	24½	23	[illegible]	3600		[illegible]	[illegible]	[illegible]	[illegible]	94	94	96	
10	5	4	"	"	7	28·8	7	24	23½	1	3500		[illegible]	[illegible]	[illegible]	[illegible]	94	95	95	
11	5	4	"	N N W.	7	24·6	8	24	23½	[illegible]	3340		[illegible]	[illegible]	[illegible]	[illegible]	94	95	96	
12	6	4	W ½ S.	"	6	34·6	8	24	22½	[illegible]	3500	11232	[illegible]	[illegible]	[illegible]	[illegible]	94	96	96	

U. S. S. F. MINNESOTA, Sept. 1st, 1858, 11·10 A. M.

Scale, 1-10th inch = 1 lb.

Steam,	10	Hot-well,	98°
Vacuum,	22½	Throttle,	¾
Revolutions,	34		

U. S. S. F. MINNESOTA, Sept. 1st, 1858.

Steam,	10	Hot-well,	97°
Vacuum,	23	Throttle,	¾
Revolutions,	34		

From the above log and diagrams we get the following data.—

Mean terminal pressure of the four diagrams, .	6·718 lbs.
Average coal per hour, . . .	4375 "
" revolutions per minute, . . .	33·9
" temperature of feed-water, . .	139°
" saturation of boilers, . . .	11-16
" throttle, ...	¾

From which the following calculation of boiler performance while using Japan coals is made, viz:

$$\frac{179{\cdot}50 \times 33{\cdot}9 \times 2}{3538} = 3{\cdot}439.$$

And

$$\frac{3{\cdot}439 \times 60 \times 64{\cdot}3}{4375} = 3{\cdot}03 \text{ lbs. water.}$$

To this must be added the per centum of useful effect lost in fuel from blowing to maintain the boiler water at a saturation of $\frac{1\frac{1}{2}}{32}$ which in this case was found to be 12, its equivalent in pounds of water evaporated being ·3636. And 3·03 + ·3636 = 3·39 lbs. of water evaporated per pound of coal, was the maximum boiler performance with Japan coals.

By examining the above log, it will be seen that the ashes and clinker for the 24 hours, exceeded the enormous figure of 60 per centum.

Remarks.—Large deposits of soot and ashes collecting on lower tube sheets and around the tubes.

Copy Steam Log of the U. S. Steamer MISSISSIPPI. CAPT. WM. C. NICHOLSON, *Commanding. At sea, August 4th,* 1856.

PORT ENGINE.

U. S. S. F. MISSISSIPPI, Aug. 4th, 1868.

Average steam per gauge,	10 lbs.	Vacuum,	26·75
Revolutions,	8·55	Throttle,	2
Lift of steam-valve,	3 ins.		

Average steam per gauge,	10·25 lbs.	Vacuum,	27·5
Revolutions,	9	Throttle,	2
Lift of steam-valve,	3 ins.		

From the above log and diagrams the following calculations of boiler performance while using Japan coals are made, viz :—

Mean terminal pressure of the diagrams,		9·31 lbs.
Average coal per hour,		2912 "
"	revolutions per minute,	9·24
"	temperature of feed-water,	135°
"	saturation of boilers,	1·75
"	throttle,	3
"	steam per gauge,	9·7 "

$$\frac{456{\cdot}72 \times 9{\cdot}24 \times 2}{2829} = 2{\cdot}983.$$

And $$\frac{2{\cdot}983 \times 60 \times 64{\cdot}3}{2912} = 3{\cdot}95 \text{ lbs. of water.}$$

To this (as in the case of the *Minnesota*) an additional per centum for loss of useful effect in fuel from blowing to maintain the boiler water at a saturation of $\frac{1\frac{3}{4}}{32}$ must be added, which is found to be 11·6, its equivalent in pounds of water evaporated being ·458; and ·458 + 3·95 = 4·408 lbs. of water evaporated per pound of coal, was the maximum boiler performance.

The residuum in clinker and ashes for this day was 36·75 per cent.

Remarks.—Immense quantities of soot and cinders collecting on the tube sheets and between tubes, rendering it necessary on one occasion to clean them while under way.

Copy Steam Log of the U. S. Steamer Powhatan, *Flag Ship of Flag Officer Tattnall.* Capt. G. F. Pearson, *Commanding. At sea, July 23d, 1858.*

H. A.M.	Speed. K.	Speed. F.	Course.	Wind. Direc.	Wind. Force.	Revolutions of Engine.	Hot-well.	Pressure of Steam.	Vacuum. S.	Vacuum. P.	Throttle.	C. L.								[illegible] ins. aver. point cutting off from com'ment of stroke, Indicd. clearance, &c.
1	9		SbW¾W.	S by W.	3	9·7	120	10·6	25¼	25¼	3	4367	1⅝	1¾	1⅝	1⅝	106	88		
2	8		"	"	3	9·5	120	10	"	"	"	4291	1¾	"	1½	"	106	81		
3	7		"																	
		4	SbyE¾E.	S S W.	3	8·9	116	9·5	"	"	"	4018	"	"	"	"	105	80½		
4	6		"	"	3	8·6	116	9·5	"	"	"	3255	"	"	"	1¾	97	80	2940	
5	6		"	SW by S.	4	9·1	116	10	25½	25½	"	3285	"	"	"	"	98	80		
6	5		"																	
	2	4	E S E.	"	4	10·7	119	10·6	"	"	"	4974	"	"	"	"	88	80½		
7	4	4	SEbE¾E.																	
	4	4	E S E.	"	4	11·1	"	10·6	"	"	"	4974	"	"	"	"	88	78		
8	9	4	"	"	4	11·6	"	10	"	"	"	6840	"	"	"	"	92	80	4800	
9	9		"	"	4	11·5	"	10	"	"	"	6840	"	1⅝	1⅝	"	90	79		
10	9		"	S W.	4	11·5	"	10·5	"	"	"	4974	"	1¾	1¾	"	93	79		
11	9		"	"	4	11·8	120	10·6	"	"	"	4526	1⅝	1¾	"	"	94	81		
12	9		E ½ S.	"	3	11·6	120	10·6	"	"	"	4774	1⅝	1⅝	"	"	98	84	4800	
Expended, 100,886 Japan coals.						Revolutions made, 15,956.							Knots run, 209·4.							
P.M.																				
1	9	4	E N E.	S W.	3	11·6	120	10·5	25½	25½	3	4018	1¾	1¾	1¾	1⅝	94	82½		
2	10		NEbE¾E	"	3	12·4	"	10	"	"	"	4774	"	"	"	1¾	91	81½		
3	9	4	"	S S W.	3	11·6	"	9·5	"	"	"	3570	"	"	"	1¾	89	80		
4	9	4	"	"	3	11·6	"	9·6	"	"	"	3804	"	"	"	"	88	78	2800	
5	9		"	"	3	11·6	118	9·5	"	"	"	3792	"	"	"	"	87	78		
6	9	4	"	"	3	11·4	120	9·5	"	"	"	4285	"	"	"	"	90	78		
7	9	4	"	SWbyW.	5	11·4	"	9·5	"	"	"	3570	"	"	"	"	90	79		
8	9	4	"	"	5	11·6	"	10	"	"	"	2430	"	"	"	"	90	79	4620	
9	10		"	"	6	11·6	"	9·5	"	"	"	4458	"	1¾	"	1¾	92	80		
10	10		"	"	6	11·8	"	9·5	"	"	"	3577	"	"	"	"	91	80		
11	10		"	"	6	11·6	"	9·5	"	"	"	3500	1⅝	"	1⅝	"	91	80		
12	11		"	"	6	11·8	"	9·5	"	"	"	2920	1⅝	"	1⅝	"	91	80	2800	

U. S. S. F. POWHATAN, July 23d, 1858.

Steam,	10·5	Revolutions,	11·4
Vacuum,	25·5	Throttle,	6
Hot-well,	110		

PORT ENGINE.

The following data deduced from the above log is the basis of the calculation for the boiler's performance with the Japan coals.

It will be observed that the terminal pressure of the diagrams is not taken, as in the case of the other ships. That course of procedure

was rejected in consequence of the frequent changes of the cut-off during that 24 hours, on account of the variableness of the wind, sea, &c. And although the results from the two modes of calculation will not vary much, yet I thought that taking the average point of cutting off as shown by the log would give a more correct result, and hence their adoption.

Average pressure of steam per gauge,	. .	9·9 lbs.
" revolutions per hour,	. .	664·9
" consumption of coal per hour,	. .	4203 "
" point of cutting off, from commencement of stroke, including clearance, &c., &c.,	.	42·9 ins.

From which we gather the following results:—

$$\frac{3848{\cdot}4 \times 42{\cdot}9 \times 2 \times 11{\cdot}08 \times 2}{1728} = 4234{\cdot}4$$

And $$\frac{4234{\cdot}4}{1064} = 3{\cdot}97 \text{ lbs. water.}$$

The loss from blowing to maintain the boiler water at its nominal density, viz: 1·75, was 12·9 per cent., its equivalent being ·510; and 3·97 + ·510 = 4·7 lbs. of water evaporated to one pound of coal.

Residuum in clinker and ashes, 22·5 per cent.

The English government have recently despatched a steamer (the *Roebuck*) to Japan, for the express purpose of practically testing these coals; the results of which will be looked for with much interest.

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*The Magnesian Light.**

Magnesium is well known as the metallic basis of magnesia; it is much lighter than aluminum, as its specific gravity is only 1·74; it is of a silvery whiteness, undergoes no change in dry air, and is subject to but slow oxidation in a damp atmosphere, and that only quite supercially; it may be hammered, filed, and drawn into threads. At the beginning of the present century its properties were developed by Davy, and still more thoroughly by Busse. To obtain it pure is an expensive process; and as no practical advantage could hitherto be made of it, no one had attempted to discover a cheaper method of getting it. It was reserved to Bunsen to perceive a new property in this metal, and to suggest a practical application of it. Magnesium takes fire at the temperature at which glass melts, and burns with a steady and extremely vivid flame. In some photo-chemical investigations by Bunsen and Roscoe, experiments were made to test the illuminating capacity of a magnesium thread, when Bunsen discovered that the splendor of the sun's disc was only 524 times as great as that of the thread. Bunsen also compared the magnesium flame with ordinary lights, and found that a burning thread of 0·297 millimetres diameter, produces as much light as 74 stearine candles, of which five go to the pound. It is plain that it only needs a mechanical device to spin magnesium when heated into the form of a thread upon spools, from

* From the Lond. Chemical News, No. 27.

which they can be run off like the strips of paper in Morse's telegraphic apparatus, to render it of practical use. Such a magnesium lamp-wick would be far more simple and complete than the preparations for the use of the electric or the Drummond light. A spool with its thread, a clock-work to wind it off, with the spirit lamp, would be easily transportable. A rival, therefore, to the strong lights hitherto used is like to spring up in Bunsen's magnesium-lamp, in all those cases where the item of expense is likely to be slightly regarded, for example, in brilliant illuminations, light-houses, &c., for extraordinary degrees of illumination may be obtained by burning several of these threads of large dimensions at once.—*Engineer.*

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*On the Influence of Science on the Art of Calico Printing.**

By Professor F. CRACE CALVERT, F.R.S.

Calico printing has partaken of the general progress of the manufacturing arts; and this can be easily understood when it is remembered that it is based upon three distinct branches of knowledge—mechanics, art, and chemistry. Not being acquainted with machinery, I shall not attempt to describe the various mechanical improvements and machines which have been introduced; but shall confine myself to stating that ever since 1815, the period at which it was first extensively applied in the print works of Lancashire, machinery has gradually supplanted hand labor, and thereby immensely decreased the cost of production, at the same time that it has improved the beauty and precision of the results obtained.

Penciling and Block-Printing.—During the early part of this century, the production of designs upon calico was performed by means of hand-blocks, made of sycamore or pear-tree wood, 2 ins. or 3 ins. thick, 9 ins. or 10 ins. long, and about 9 ins. broad. The face of the block was either carved in relief into the desired pattern, like ordinary wood-cuts; or the figure was formed by the insertion edgewise into the wood of narrow slips of flattened copper wire, and the patterns were finished by the hand labor of women with small brushes, called pencilings. Owing to a strike amongst the block printers, in 1815, to resist the threatened introduction of machinery, great efforts were made on the part of the employers to render themselves independent of hand labor; and the result has been the gradual introduction of cylinder-printing. Without entering into the intricate details of the steps by which the art of engraving has been carried to its present high degree of perfection, I shall simply give an outline of the successive improvements alluded to.

Engraving.—The first kind of roller used was made by bending a sheet of copper into a cylinder, soldering the joint with silver, and then engraving upon the continuous surface thus obtained.

The second improvement consisted in producing the pattern on copper cylinders obtained by casting, boring, drawing, and hammering. In this case, the pattern is first engraved in intaglio upon a roller of

* From the London Engineer, No. 220.

softened steel of the necessary dimensions. This roller is then hardened and introduced into a press of peculiar construction, where, by rotary pressure, it transfers its design to a similar roller in the soft state, and the die being in intaglio, the latter, called the "mill," is in relief. This is hardened in its turn, and by proper machinery is made to convey its pattern to the full-sized copper roller. This improvement alone reduced the cost of engraving on copper rollers many hundreds per cent.; and, which is of far greater importance, made practicable an infinite number of intricate engravings which could never have been produced by hand labor applied directly to the roller.

A further improvement was made by tracing with a diamond on the copper roller, covered with varnish, the most complicated patterns by means of eccentrics, and then etching.

The combination of mill engraving with the tracing and etching processes naturally followed, adding immensely to the resources of the engraver and printer in the production of novel designs.

Another development of this art is the tracing of patterns on the surface of rollers, which has been effected by machines constructed on the principle of the pentagraph. Although this invention dates from 1834, still it is only of late years that it has been successfully applied.

But if mechanical art has greatly assisted the engraver, chemistry has rendered him equally important services, by enabling him to abandon costly and cumbrous modes of impressing by force the designs on the cylinder, substituting for them a great number of etching processes. By some of these processes, as by every other addition to the resources of the engraver, an entirely new and beautiful class of engraving is produced, unattainable by any other known means.

A very recent improvement is highly interesting in a scientific point of view. It is the application of galvanism to the diamond tracer. By combining the galvanic action with the eccentric motion, most beautiful and delicate engravings can be produced. This is effected by tracing the pattern with a varnish on a zinc cylinder, which is so placed in the engraving machine, that as a needle passes over its surface, and comes in contact with the zinc, the galvanic current is established, and, by simple machinery, causes the diamond to trace the corresponding pattern on the copper roller. The communication is so rapid and so precise, that this invention of Mr. Gaiffe, of Paris, bids fair to produce very important results. Galvanism is also made use of, for producing effects on roller surfaces by depositing copper thereon.

To give an idea of the extraordinary influence which the introduction of machinery and improvements in engraving have had in cheapening the cost of printed calicoes, I may state that large furniture patterns, such as are required for Turkish, Egyptian, and Persian markets, into which sixteen colors and shades enter, would have cost formerly from 30s. to 35s. per piece, because they would have required sixteen distinct applications of as many different blocks, and would have occupied more than a week in printing, where the same piece can now be printed in one single operation, which takes three minutes, and costs 5s. or 6s. So rapid is the progress of one branch of manu-

facture in connexion with another, that it has only recently been possible to produce the rollers capable of performing this operation, that is to say, cylinders of copper 43 ins. in circumference by 44 ins. long. For light styles of printing, the time required to print a piece of 36 yards is not more than one minute.

Chemistry.—But the discovery which has exercised more influence than any other on the progress of calico printing, is the application of chlorine gas as a bleaching agent. Previously to the employment of this gas (chiefly as bleaching powder), the imperfect bleaching of a piece of calico required six weeks; and as it had to be exposed to the action of the atmosphere, a large surface of land was required. Further, at that time, bleachers had to use potashes imported from Canada; whereas, at the present time, thanks to the progress of chemical knowledge, not only is soda-ash manufactured in this country, but, by the application of bleaching powder, calicoes are much better bleached in twenty-four hours than they were formerly by a six weeks' exposure to the atmosphere; and even when an extra cleaning and whiteness is required, as for madder goods, only two days are necessary. The aid of machinery renders possible the continuous process, that is to say, several hundred pieces of grey calico are sewn together, end to end, and made to pass from one operation to another, without any pause, until they are bleached. So rapid and economical is this method that the cost of bleaching a piece of calico does not exceed one or two pence. Chlorine, again, renders a great service to the calico printer, by enabling him, after his madder goods have been produced and soaped, to obtain fine whites without the necessity of exposing them for several days in the meadows to the action of the atmosphere. In fact, the discovery of garancine and alizarine, and their application to calico printing, have facilitated the production of madder styles at very low cost, as the whites of such goods require no soaping, and only a little bleaching or cleaning powder.

Cotton has this peculiarity as distinguished from wool and silk, that it will not fix any organic color, excepting indigo, without the interposition of a mordant, which is generally a metallic oxide or salt. The two most important discoveries in connexion with this necessity of calico printing were: first, that made in 1820, by Mr. George Wood, of Bankbridge, who found out the means of preparing calicoes with peroxide of tin, which enabled printers to produce a large variety of prints called steam goods; and, secondly, that of Walter Crum, Esq., F. R. S., who, in a paper presented to the British Association, at Aberdeen, in 1859, showed that the tedious process of ageing madder mordants for three or four days, might be dispensed with by passing the goods during a quarter of an hour through a moist atmosphere, at a temperature of 80° to 100°, where the mordants absorb the required quantity of moisture, and then rapidly undergo the chemical changes necessary to fit them for producing the black, purple, lilac, red, pink, and chocolate colors, which the madder root will yield immediately in the dyebeck, according to the nature of the mordant previously fixed in the cloth.

As it is impossible in the brief space of an hour to convey an idea how various colors are produced on prints, I shall confine my remarks to illustrating the interesting fact that abstruse science has brought to light various substances, which have lately proved valuable accessories to the resources of the calico printer. Thus Dr. Prout, some thirty or forty years ago, made the curious discovery that uric acid possessed the property of giving a beautiful red color, when heated with nitric acid, and then brought into contact with ammonia The substance thus obtained was further examined by Messrs. Liebig and Wöhler, in a series of researches which have been considered as amongst the most important ever made in organic chemistry; and this substance they called murexide. In the course of these investigations, they also discovered a white crystalline substance called alloxan. For twenty years both these substances were only to be found in the laboratory; but in 1851, Dr. Saac observed that alloxan, when in contact with the hand, tinged it red. This led him to infer that alloxan might be employed to dye woolens red; and further experiments convinced him that if woolen cloths were prepared with peroxide of tin, passed through a solution of alloxan, and then submitted to a gentle heat, a most beautiful and delicate pink color resulted. Subsequently, murexide was employed and applied successfully by Mr. Depouilly, of Paris, to dyeing wool and silk, and to printing calicoes, by the aid of oxide of lead and chloride of mercury as mordants; but the great obstacle to its extensive use was the difficulty of obtaining uric acid in sufficient quantity for its manufacture. The idea soon occurred to chemists to extract it from guano; and this is the curious source whence the chief supply of uric acid is obtained, and which enables Edmund Potter, Esq., and other printers, to produce the color called Tyrian purple.

Another example will be found in the successive scientific discoveries which have led to the discovery of the recently popular color, mauve. Lichens, which have been the subject of extensive researches on the part of Robiquet, Heeren, Sir Robert Kane, Dr. Schunck, and especially of Dr. Stenhouse, have yielded to those chemists several new and colorless organic substances, which, under the influence of air and ammonia, give rise to most brilliant colors, and amongst these are orchil and litmus. Dr. Stenhouse, in a most elaborate paper published by the Royal Society in 1848, pointed out two important facts: first, that the color-giving acids could be easily extracted from the weed by macerating it in lime water, from which the coloring matters were easily separated by means of an acid; and, secondly, the properties of certain coloring acids, which gave M. Marnas, of Lyons, the key which enabled him to produce commercially from lichens, a fast mauve and purple which up to 1857 had been considered impossible of attainment.

The commercial production by Mr. W. H. Perkin of another purple at the same time is not less interesting. Some thirty or forty years ago, Dr. Runge obtained from coal-tar six substances, amongst which was one called kyanol, which substance was thoroughly examined by

Dr. W. A. Hofmann, who proved it to be an organic alkaloid, and identical with a substance known by the name of aniline. Owing to the subsequent study of this substance by that eminent chemist, and the discovery that it yielded a beautiful purple color when placed in contact with bleaching powder, his pupil, Mr. W. H. Perkin, was induced to make experiments with a view to producing commercially a fast purple, in which he succeeded, and secured it by a patent in 1857. The process devised by this chemist is exceedingly simple. It consists in oxidizing aniline by means of bichromate of potash and sulphuric acid. I shall not attempt to give any further details on this subject, as they have been very ably described by Mr. Robert Hunt in the *Art Journal.*

More recently, Mr. Renard found a method of producing also from aniline by means of chlorine compounds a most splendid rose color, called by him fuchsiacine; and within the last few months, Mr. David Price has also succeeded in producing from aniline, by the employment of peroxide of lead, either a fast purple or a pink, called by him roseine, and a fast blue according to the mode of operating. All these colors require special mordants to fix them on calicoes or muslins; and the beautiful specimens which I have the honor to lay before you I owe to the kindness of Messrs. James Black and Co., and Messrs. Boyd and Hamel of Glasgow, who have fixed the last-mentioned colors by means of azotized principles, such as albumen, lactarine. &c.,

I cannot give a better idea of the immense magnitude of the calico-printing trade than by quoting the number of yards exported, which amounted in 1858 to 785,666,473, and give a price value of £13,-147,280.

I cannot conclude without expressing also my thanks to Mr. Wood, of the firm of Wood and Wright, and Mr. R. Leake, of the firm of Lockett, Sons, and Leake, Messrs. Dalglish and Faulkners, for the numerous and valuable specimens which they have kindly lent me to illustrate my discourse; and especially to Mr. W. Grant for the loan of a most interesting book, containing the patterns belonging to the late firm of Sir Robert Peel, Bart., which bears the date of 1790.

Persistent Activity of Light.

We take the following interesting facts on this subject from the *Cosmos:*—"Some weeks ago, M. Niepce de Saint-Victor came to see us, bringing with him a large tin tube, closed not with sealing-wax but hermetically, and rendered inaccessible to all external agencies except variations of temperature, by a complete soldering with tin or lead. He opened the tube in our presence, exposed, without unrolling it, a sheet of paper prepared with tartaric acid and insolated, which he had inclosed in the tube nearly a year before, poured on this sheet a few drops of nitrate of silver, and showed us that the nitrate was almost immediately blackened, exactly as it would have been in a strong light. It was impossible not to attribute this instantaneous action to the persistent action of the light absorbed a year ago by the

paper soaked in tartaric acid. If the experiment was more successful this time, although kept for a longer period, it was because of the much more perfect closure of the tube; and that which happened after a year would certainly happen after five or six years."

"Again, M. Busk has established the following fact: Plunge a sheet of paper into a solution of a properly chosen acid, organic or inorganic, for example, acetic or tartaric acid; dry it; render it sensitive by the bath of nitrate of silver, and dry it again; place it in contact with the drawing which it is desired to reproduce for a half hour or more; then expose the paper to the sun's rays, and a negative image of the drawing will be seen, which may be fixed by washing with common water. It is not even necessary that the exposure to the light should take place at once; the paper may be preserved for several days between two sheets of white paper without losing its property of developing the latent image under the influence of the sun's rays. What is more difficult to explain is that there is no necessity of insolating or exposing to light the original picture. M. Busk usually employs the following formula:—*Solution of organic acid:* water, 90 grammes; crystallizable acetic acid, 30; dip the sheet simply in it. *Bath:* water, 25 grammes; nitrate of silver, 3·60 grammes; crystallizable acetic acid, 3·5 grammes; the sheet may either be laid on the bath successively on its two sides, or be washed on each face by a brush."

"To these facts, or to their interpretation, M. Baron Thenard would oppose the following experiment which he has communicated to the *Philomathic Society.*—1st. During the night he *disinsolated* a sheet of common paper by exposing it to the vapor of water for an hour. 2d. He then divided the paper into two parts; one was laid aside for comparison, the other was rolled up and placed in a glass tube, to one end of which ozonized oxygen was supplied; at the end of a quarter of an hour the ozone was distinctly perceived at the other extremity; the paper was then withdrawn. 3d. This paper used in the same manner as M. Niepce's insolated paper produced the same effects; the paper kept for comparison produced none of them. 4th. A paper treated with chlorine or nitrate of silver and then ozonized gave, on the contrary, no sensible result. 5th. Common paper ozonized and kept for some time in a test tube disengages a smell which is not that of ozone but that of a very diffusible essence. What shall we conclude from this? added M. Thenard—That the phenomena of insolation described by M. Niepce are chemical phenomena, determined indirectly by the light, which acts in this matter only as an intermediate agent."

Manufacture of Stearine Candles.

At the meeting of the French Academy of Sciences of 18th June, 1860, M. Dumas presented a note from M. Cambacérès, who has studied thoroughly and for a long time the interesting question of the saponification of the fat-acids, their solidification, and transformation

into stearine candles. He has discovered that by substituting dilute nitric acid for the concentrated acid usually employed, and assisting the action by a long contact under the influence of heat, the quantity of the fatty matter which solidifies is considerably increased, and a very great economy introduced into the manufacture.

On the Thermodynamic Theory of Steam Engines with dry Saturated Steam, and its application to practice. By W. J. MACQUORN RANKINE, C. E., F. R. S., &c.*

Phil. Trans. 1859, p. 177; and Phil. Mag. S. 4. vol. xviii. p. 71.

This supplement gives the dimensions, tonnage, indicated horse-power, speed, and consumption of fuel, of the steam-ships whose engines were the subjects of the experiments referred to in the original paper. Results are arrived at respecting the available heat of combustion of the coal employed, and the efficiency of the furnaces and boilers, of which the following is a summary :—

No. of Experiment.	Kind of Boiler.	Total heat of combustion of 1 lb. of coal in ft-lbs., estimated from chemical composition.	Available heat of combustion of 1 lb. of coal in ft-lbs. computed from efficiency of steam and weight of coal burned per I. H. P.	*Available heat*, total heat = efficiency of furnace and boiler.
I.	Improved Marine Boilers of ordinary proportions.	10,000,000	5,420,000	0·542
III.		10,000,000	5,300,000	0·53
II.	Boiler chiefly composed of small vertical water-tubes, with very great heating surface.	11,560,000	10,110,000	0·88

$$\text{Available heat of combustion of 1 lb. of coal} = \frac{1,980,000 \text{ ft.-lbs.}}{\text{Efficiency of steam} \times \text{lb. coal per I. H. P. per hour}}$$

* From the Lond., Edin., and Dub. Philosophical Mag., June, 1860.

For the Journal of the Franklin Institute.

Particulars of the Clipper Bark James Welsh.

Hull built by E. F. Williams, Greenpoint, L. I. Owner, F. Alexandre, New York City. Commander, Capt. W. Magill. Intended service, New York to Balize (Honduras).

HULL.—Length of keel, 110 feet. Do. of main deck, 120 feet. Do. over all, 129 feet. Breadth of beam at midship section, 28 feet. Depth of hold, 16 feet 6 inches. Frames of white oak and yellow pine, and very securely fastened. Tonnage, 350 tons, but possesses a frame equal to a vessel of 600 tons.

Remarks.—In the erection of this vessel, there have been many im-

portant improvements upon the old method of ship-building, particularly in its internal arrangements. Her forecastle is admirably adapted for the comfort of seamen, being far superior to the old and miserably ventilated ones, which have invariably been so detrimental to the health of sailors. It is erected on the main deck, having two gangways on each side of the chain lockers, and a commodious room on either side of the gangways, each possessing four large berths.

These gangways are sufficiently large to admit of five persons in each to be seated at meals, and can, when necessary, be used to change clothing and as a protection from storms, whilst the sleeping apartments will at all times keep perfectly dry.

Each of the rooms contains a ventilator, which, when used in concert with the hatch in the topgallant-forecastle and the gangways, will insure the presence of a continual current of fresh air.

The after-house of this vessel (constituting cabin and dining-room) is 28 feet in length, and contains four state-rooms on each side for the accommodation of passengers. The forward portion of the house is separated from the after part, for the purpose of stowing hides, dry goods, and miscellaneous merchandize, by which arrangement they receive a thorough ventilation during the passage, thereby preventing that unhealthy miasma arising, as is usually the case when such articles are stowed in the hold.

In addition to these features, there are two tanks in her cockpit of sufficient capacity to hold 500 gallons of water each. The main rail and bulwarks included, are seven and a half feet in height and of great strength, in order to protect her deck load, which, upon all her return voyages, will consist of mahogany.

The above improvements are the design of her owner, and are worthy the attention of ship builders, ship owners, and all others who are interested in alleviating the many trials and discomforts of a much abused and sadly neglected class—our sailors. E. B.

Safety of Vessels at Sea.

A Dr. Brevard, of Grenoble, describes in the *Cosmos* a means of preserving a ship from sinking at sea, which, although not new as a proposition, has never to our knowledge been adopted, and merits a fair experiment at all events. The plan appears to consist in rendering the various compartments of the vessel air-tight, and arranging proper openings along the keel which may be closed by plugs or stop-cocks. If the vessel springs a leak, the compartment into which the leak opens is closed air-tight, and air forced in by a force-pump until the water is driven out at the leak, which is then to be stopped, and one or more of the escapes along the keel being opened, the air is continually forced in until all the water is expelled. Should fire take place below, the vessel may be scuttled by opening the lower escapes until the fire is extinguished, and be then raised again by means of the pumps. The same pumps may be used to ventilate the holds and ca-

bins of the vessel. In a steamer the force-pumps may be worked either by connexion with the main engine or by the feed engine; and when it is considered that a pressure of one additional atmosphere will correspond to a column of about thirty feet of water, and that our india-rubber goods furnish a cheap and simple way of rendering any opening practically air-tight, the plan seems feasible enough; at all events, considering the important use for which it is purposed, deserving of serious study.

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*On the Explosion of Hypophosphite of Soda.** By M. TROMMSDORFF.

Under the heading of "Caution,"† Dr. L. C. Marquart describes a violent explosion of the above salt, while its solution was being evaporated in a porcelain capsule, placed in a heated sand bath, for which reason too high a heat was assigned as the cause of the explosion. It was therefore thought necessary to avoid evaporating such a solution, either over the fire or in a sand bath, but to employ altogether a water bath for its evaporation. This operation has been carried on very frequently in my laboratory without the occurrence of the least accident, but last spring I experienced by a painful accident that even the low temperature of boiling water is no safeguard against explosions of this salt.

The neutral solution of hypophosphite of soda was evaporated in small portions in a porcelain dish, heated by a simple water bath, the concentrated liquid being constantly stirred with a glass rod or a porcelain spatula. The last portion had become nearly dry, when a violent explosion took place, breaking all the windows of the laboratory and seriously lacerating the face of the attending workman. Being near at hand, and supposing the explosion to have been caused by the neglect of the water bath, I hurried to the spot, but found the bath filled with boiling water, and was unable to discover the least suspicious circumstance from which the cause of the accident might have been explained.

The preparation which the author is using now is of French manufacture, and has a strong alkaline reaction. Should it, in this state, be less subject to explosions, it would be highly interesting to hear of the experience of the French and other chemists with regard to this new medicinal salt, which they are preparing in enormous quantities.

* From the Lond. Chemical News, No. 29. † *Archiv d. Pharm.*, lxxxv, 384.

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*Improvement in the Manufacture of Starch.**

A patent has recently been obtained by John Hamilton, of Belfast, for submitting starch—after it is deposited in the manufacturing process—to the action of a hydraulic press, in suitable boxes, so as to press all the water out of it, instead of evaporating all the moisture in artificially heated rooms, according to the usual practice. A great saving in fuel is thus effected by well known and very simple means.

* From the Lond. Chemical News, No. 10.

*Bitumenized "Paper" Pipes.**

The ingenious idea of hardening paper by means of an admixture of bitumen under the influence of hydraulic pressure, so as to convert it into a substitute for iron, is due, it appears, to M. Jaloureau, of Paris. The world has already become familiar with the utility and value of *papier maché* as a substitute for stone or marble in moulding, architectural castings, busts, and statues: it has also heard recently that the Chinese constructed their cannon of prepared paper lined with copper, and that they even make paper pipes,—that an eccentric character at Norwood has built himself a house of paper,—and that our American friends have invented a veritable paper brick;—but nothing, it is believed, has lately come before the British public, in the way of paper, so curious, and yet practicable, as these bituminous paper pipes. Testing experiments, conducted under the great clock-tower at the Houses of Parliament, are reported to have "proved that the material, while it possessed all the tenacity of iron, with one-half its specific gravity, had double the strength of stoneware tubes, without, moreover, being liable to breakage, as in the case of other material, and which frequently causes a loss to the contractor of some 20 or 25 per cent. on the supply." In order to test their strength, two of these bituminous paper pipes of 5-inch bore and half an inch thick were subjected to hydraulic power, and they are said to have sustained, without breaking or bursting, a pressure of 220 lbs. to the square inch, or equivalent to 506 feet head of water. The cost of the pipes is understood to be about one-half the cost of iron. Specimens of pipes employed in the transmission of gas at the Palace des Invalides during the last eighteen months were exhibited by Messrs. Joske & Young, the proprietors.

* From the Lond. Builder, No. 888.

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*Action of prolonged Heat and Water on different Substances.**

Mr. H. C. Sorby, an Englishman we believe, sends to the Academy of Sciences an account of some experiments he has made on the above subject. He put different substances and various solutions in glass tubes, sealed then hermetically, and then placed them in the boiler of a high pressure engine, and kept them there exposed to a temperature ranging from 145° to 150° C. for some months. Others he placed in an ordinary kitchen boiler, in which the temperature varied from 75° to 100° C. The first facts noticed are the decomposition of the glass tubes employed. Crown glass resisted the action best—better even than Bohemian—but it was sometimes acted on at but slightly elevated temperatures. English flint glass was easily decomposed by the prolonged action of water below 100°. A fragment of flint or Bohemian glass enclosed in a tube of crown glass with a *little* water, was more quickly decomposed than with much water. A moderately strong solution of nitric acid had little or no action on flint glass at 145° or 150°, while pure water soon changed it into a white crystalline mass. Wood exposed to a temperature of 145° without water,

* From the Lond. Chemical News, No. 30.

underwent but little change, while some with water became quite black. A brilliant black substance separated from the wood, but the water remained quite clear, although it had an acid reaction, due no doubt to acetic acid, and when the tube was opened a good deal of gas escaped. Some of the results obtained illustrate the pseudomorphosis of minerals, and of these experiments we hope the author will soon publish a fuller account.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JUNE 1, TO JUNE 30, 1860.

Air Engines,	O. M. Stillman,	Stonington,	Conn.	26
———	"	"	"	26
Amalgamator,	G. E. Mills,	City of	N. Y.	26
Apples,—Cutting and Coring	G. C. Wright,	Le Roy	Ohio,	26
Auger,—Tenoning	Wm. A. Clark,	Bethany,	Conn.	12
Bagasse Furnaces,	C. A. Desobry,	Plaquemine,	La.	19
Bark,—Separating Qualities of	Joseph Brakely,	City of	N. Y.	5
Barometers,	Lum Woodruff,	Ann Harbor,	Mich.	5
Barrels,—Securing Heads in	G. W. Banker,	Medford,	Mass.	12
Bed Bottom,—Spring	W A Morse & D S Beans,	Boston,	"	19
Bedstead,	Reuben Jenkins,	Covington,	Ky.	5
———	Thomas Wall,	Jones' Station,	Ohio,	5
Bee-hives,	K. P. Kidder,	Burlington,	Vt.	26
Bells,—Ringing	Balthasar Kitt,	Cincinnati,	Ohio,	5
Belts,—Strain on Pulley	Duff and Keating,	City of	N. Y.	19
Blind Slat Machine,	Stephen Jackson,	Ossippee,	N. H.	19
Blowers,	Rufus Lapham,	City of	N. Y.	19
Boats,—Hook for Suspending	C. L. Williams,	Quincy,	Fla.	5
Bolt for Doors,	N. W. Bonney,	Victoria,	Texas,	26
Bolts for Store Shutters,	Wm. C. Fisher,	Charlestown,	Mass.	26
Bolting Chest,	Cogswell & McKiernan,	Buffalo,	N. Y.	12
Boom Jaws,—Elastic Lining	O. P. Rowland,	Jamesport,	"	5
Bonnet Box,	C. A. Taylor,	Chicago.	Ill.	26
Boot-jack,	George Wheeler,	City of	N. Y.	26
Boot & Shoe Cleaning Appar.	James Chesley,	Concord,	N. H.	19
——— Wiper,	J. K. Staman,	Mifflin,	Ohio,	5
Boots,—Congress	H. S. Holmes,	Lynn,	Mass.	19
Boots & Shoes,—Heel Guard	W. A. Harris,	Providence,	R. I.	5
Brakes,—Railroad	Nehemiah Hodge,	N. Adams,	Mass.	12
———	J. H. Steiner,	Philadelphia,	Penna.	19
———,—Self-acting Wagon	Wm. May,	Winchester,	Ohio,	5
Bran Dusters,	J. W. Houghtelin,	Du Quoin,	Ill.	26
Bridges,—Iron	J. P. Fisher,	Rochester,	N. Y.	26
Bridle Bit,	Henry Crane,	City of	"	5
Bung Cutter,	John Tiebout,	Brooklyn,	N. Y.	5
Burglars Alarm,	J. C. Huntley,	Philadelphia,	Penna.	12
Butter Worker,	Wm. H. Wiley,	Lockport,	N. Y.	12
Buttons,	Stephen Krom,	City of	"	5
Cap Fronts,—Mode of Binding	Leon Londisky,	City of	N. Y.	26
Carpenters Square,	James Hathen,	Philadelphia,	Penna.	26
Carpet Stretcher,	H. M. Hartshorn,	Malden,	Mass.	26
Carpets,—Laying and Stretch'g	F. Cist and others,	St. Louis,	Mo.	12
Casting Metals,—Fac'g Moulds	J. B. Hyde,	Newark,	N. J.	5
Chains,	P. D. Cummings,	Portland,	Me.	5
Chisel for Opening Boxes,	D. M. Dumzack,	Salem,	Mass.	26
Chronometer Escapement,	Thomas Morrison,	Kingston,	N. Y.	12
Churn,	N. D. Ross,	Braintrem,	Penna.	5
———	O. W. Stanford,	Cincinnati,	Ohio,	12
———	Harry Abbott,	N. Huron,	N.Y.	19

Churn,	S. A. Kerr,	Arbor Hill,	Va.	19
———	C. Wright & W. Phelps,	Sycamore,	Ill.	19
Claw Bar,	G. H. Beard,	Cincinnati,	Ohio,	12
Clothes Wringer,	Higgins & Willard,	Somerville,	Mass.	19
Clocks,—Calendar	Eben Pritchard,	Waterbury,	Conn.	5
Cocks,—Pull	George Leach,	City of	N. Y.	5
Coffee Pots,	Thomas Yates,	Dubuque,	Iowa,	19
Core Boxes,	J. S. Harper,	Baltimore,	Md.	5
Cornices of Sheet Metal,—Form.	John Lee,	Bolivar,	Ohio,	12
Corn Huskers,	D. M. Mefford,	Jeffersonville,	Ind.	26
—— and Cob Crushers,	Amos Glover,	Powhatan Pt.,	Ohio,	5
—— Planters,	Daniel Moyer,	N. Hamburgh,	Penna.	5
———	Ptollman Stover,	W. Alexandria,	Ohio,	5
———	Davis Dutcher,	Blue Grass,	Iowa,	26
———	T. S. Mills,	Iberia,	Ohio,	26
———	Levi Morris,	Woodbury,	Ill.	26
———	D. C. Myers,	Richmondale,	Ohio,	12
———	J. L. Smith,	Neoga,	Ill.	26
———	Taylor & Sprague,	Prairie City,	"	26
—— Shellers,	E. A. Smead,	Tioga,	Penna.	5
———	J. P. Smith,	Hummelstown,	"	19
Cotton Bales,—Iron Tie for	C. C. Bier,	New Orleans,	La.	26
——— Scrapers,	J. M. Cobb,	Jackson,	Tenn.	26
Coupling and Uncoupling Cars,	Wm. A. Herrick,	Leeds,	Me.	19
Couplings,—Car	J. S. Sammons,	City of	N. Y.	5
———	L. and W. H. Waddel,	Staunton,	Va.	5
———	Wm. W. Culpepper,	Augusta,	Ga.	12
——— for Railroad Cars,	George Lavally, Jr.,	Champlain,	N. Y.	26
Coupling for Shafting,	Samuel Hall,	City of	"	5
———	H. L. Haynes,	Keene,	N. H.	26
Cultivator Teeth,	C. H. Sayre,	Utica,	N. Y.	19
———	Turner & Smith,	Sunapee,	N. H.	26
Cultivators,	Vines Harwell,	Walker Co.,	Ga.	5
———,—Cotton	W. F. Johnson,	Wetumpka,	Ala.	5
———	R. M. Brooks,	Greenville,	Ga.	26
———	J. F. Cameron,	Livingston Co.,	Mo.	26
———	James Charlton,	Alleghany,	Penna.	26
———	O. F. Fitch,	Morristown,	Ind.	26
———	T. and R. Kinghorn,	Morgan,	Ohio,	26
———	J. M. Williams,	Greenville,	Ga.	26
Cup,—Telescopic Drinking	P. H. Niles,	Boston,	Mass.	5
Cut-off for S'm. Engs.,—Variable	David Fellenbaum,	Lancaster,	Penna.	5
Currying Knife,	Wm. P. Moses,	Exeter,	N. H.	5
Curtain Slide,—Window	Gregor Trinks,	Jersey City,	N. J.	26
Cutlery,—Soldering Handles of	E. A. Godfrey,	Hartford,	Conn.	12
———	"	"	"	12
Dating Machine,	G. J. Hill,	Buffalo,	N. Y.	26
Ditching Machines,	P. W. Adaire,	Hays' Creek,	Miss.	5
Dove-tailing Machines,	H. W. Jelliff,	Appleton,	Ohio,	12
Drills,—Rock	E. L. Foote,	Springfield,	Ill.	5
Drill Rest,	Cornelius Teachout,	Waterford,	N. Y.	19
Dry Dock,—Marine	H. J. Crandall,	New Bedford,	Mass.	12
Dulcimers,	John Low,	Clinton,	"	19
Dynanometers,	Warren & Damon, Jr.,	Boston,	"	26
Eave Troughs,—Making	Ludlow Pierson,	Jeffersonville,	Ind.	26
Egg Beater,	McLean & Morley,	City of	N. Y.	19
Electricity,—Utilizing Atmos.	H. C. Vion,	Paris,	France,	19
Envelope,	Benjamin Morrison,	Philadelphia,	Penna.	19
Faucets,	D. H. Thorp,	Chelsea,	Mass.	19
———	I. C. Tate,	New London,	Conn.	12
Fenders for Docks, Wharves, &c.,	Jacob Moomey,	Clinton,	Iowa,	19

Fibrous Materials,—Surfacing	Wm. Fuzzard,	Charlestown,	Mass.	19
Files,—Manufacture of	M. D. Whipple,	Charlestown,	Mass.	26
Filters,	T. C. Simonton,	Paterson,	N. J.	26
Fire Arms,—Self-loading	N. W. Brewer,	Williamsport,	Penna.	12
———	James Lord,	Minersville,	"	12
—— Brick,	Eben Seavey,	Boston,	Mass.	12
—— Engines,—Nozzle for	J. C. Howels,	Madison,	Wis.	26
—— Escape,	W. B. Avery,	Cambridge,	Mass.	5
———	C. W. Crosley,	City of	N. Y.	19
———	J. J. Holwell,	"	"	26
———	Wm. McCord,	Sing Sing,	"	26
———	Patten and Terry,	Albany,	"	26
—— Wood,—Bundling	C. J. Hobe,	City of	"	19
Flour,—Machines for Packing	S. A. Clapp,	Hamilton,	Ill.	5
Fog Alarms,	C. L. Daboll,	New London,	Conn.	26
Fruit,—Apparatus for Drying	Isaac Randall, 2d,	Claremont,	N. H.	19
Fruits,—Machine for Stoning	Robert McCormick,	Greenville,	Va.	26
Furnaces,	C. F. Baxter,	Boston,	Mass.	19
Furniture,—Folding	Albert Tracy,	U. S. A.,	——	12
———,—Polish for	André Sabatier,	City of	N. Y.	19
Gauge for Filling Barrels,	W. H. Noyes,	Boston,	Mass.	5
Game-box,	S. F. Brooks,	Weston,	"	19
Garter,	J. P. Fuller,	City of	N. Y.	26
Gas Burners,	Wendell Wright,	"	"	12
———	Woodworth & Wethered,	San Francisco,	Cal.	12
———	James McGlensey,	Philadelphia,	Penna.	19
—— Holders,	O. L. Lawson,	City of	N. Y.	26
——,—Manuf. of Illuminating	Levi Short,	Buffalo,	"	12
—— Metres,—Liquids for Fluid	James Taylor,	Dartmouth,	Mass.	5
—— Regulators,	S. H. Whitaker,	Cincinnati,	Ohio,	12
——,—Broiling or Roasting by	W. F. Shaw,	Boston,	Mass.	19
—— Tubes,—Flexible	John Butler,	Brooklyn,	N. Y.	12
Gases,—Naphthalizing	E. H. Ashcroft,	Boston,	Mass.	5
Gearing,	P. D. Cummings,	Portland,	Maine,	5
Grain Binders,	Herman Kaller,	Perry,	Ill.	5
———	W. W. Burson,	Yates City,	"	26
——— Separators,	McGahey and Foote,	McGaheysville,	Va.	12
Grindstones,—Dressing	J. F. Schuyler,	Philadelphia,	Penna.	5
Gun,—Toy	W. H. Stevens,	Syracuse,	N. Y.	12
Hame Tug and Buckle,	J. S. Topham,	Washington,	D. C.	12
Harrows,	D. C. Colby,	Newport,	N. H.	26
———	S. A. and C. C. Morgan,	Auburn,	N. Y.	26
Harvesters,	Robert Bryson,	Schenectady,	"	5
———	S. and J. H. Barley,	Longwood,	Mo.	19
———	Joseph Woodruff,	Rahway,	N. J.	5
———	Benaiah Titcomb,	Baltimore co.,	Md.	5
———,—Automatic Rakes	John Ollis,	Bloomington,	Ill.	26
———,—Raking Attachment	Daniel Guptail,	Elgin,	"	26
———,——— Apparatus	A. B. Smith,	Clinton,	Penna.	19
Hat Conformatures,	John Dickson, Jr.,	Brooklyn,	N. Y.	5
—— Cushion,	A. D. Purinton,	Dover,	N. H.	26
Hats,—Cigar Rack for	F. I. Miller,	Brooklyn,	N. Y.	19
Hay Elevators,	Wm. E. Durkee,	Fort Edward,	"	12
——,—Loading	Wm. Dixon,	Chicago,	Ill.	26
———	T. J. Jolly,	Olean,	Ind.	26
——,—Unloading	H. H. Angell,	Clermont,	Iowa,	26
Heating Air by Steam,	James Hollingsworth,	Chicago,	Ill.	5
——— Apparatus,	Lyman Bridges,	"	"	19
Hinges,	A. W. Sweeny,	Washington,	D. C.	26
Hinge,	H. M. Zimmerman,	"	"	26
Hook,—Self-mousing	J. R. Henshaw,	Middletown,	Conn.	12
Horse-powers,—Gearing for	Cyrus Avery,	Tunkhannock,	Penna.	5

Horse-shoes, .	T. M. Coleman, .	Philadelphia,	Penna.	12
Hose Pipe, .	George Smith, .	Macon,	Ga.	12
Hot-air Engine, .	Wm. D. Grimshaw, .	Newark,	N. J.	19
Hydrants, .	Alfred Johnson, .	Philadelphia,	Penna.	12
India Rubber,—Treatment of	A. K. Eaton, .	City of	N. Y.	19
Inoculating,—Apparatuses for	Alfred Stauch, .	Philadelphia,	Penna.	12
Jars,—Moulds for .	George Scott, .	Cincinnati,	Ohio,	5
Key Seats,—Mach. for Cutting	W. C. Bement, .	Philadelphia,	Penna.	5
Lamps, .	E. J. Hale, .	Foxcroft,	Me.	12
——— .	Jennison and Hale,	"	"	12
——— .	Chas. Miller, .	St. Louis,	Mo.	12
——— .	O. and H. S. Snow,	West Meriden,	Conn.	12
——— .	E. J. Hale, .	Foxcroft,	Me.	19
——— .	" .	"	"	26
———,—Coal Oil .	R. S. Merrill, .	Lynn,	Mass.	19
———,—Vapor .	Joseph Clarke, .	Syracuse,	N. Y.	12
—————— .	C. W. Richter, .	Madison,	Ga.	12
—————— .	George Walker,	Philadelphia,	Penna.	26
Lath Machines, .	McLean & Gummer,	Indianapolis,	Ind.	26
Leather,—Buffing and Reducing	Joshua Turner, .	Cambridgeport,	Mass.	5
———,—Finishing .	S. P. Cobb, .	S. Danvers,	"	5
———,—Skiving	E. T. Ingalls, .	Haverhill,	"	5
Leather-splitting Machs.,—Feed	D. H. Chamberlain, .	West Roxbury,	"	5
Lifting Handles, .	Joseph Ottner, .	New Britain,	Conn.	26
Light Joints,—Drop .	T. G. Arnold, .	City of	N. Y.	5
Lock, .	E. W. Brettell, .	Newark,	N. J.	26
Locks, .	Linus Yale, Jr., .	Philadelphia,	Penna.	12
Lozenge Machines,	Rhoda Sowle, .	Fall River,	Mass.	19
Lubricating Journals, .	Andrews & Carr, .	Palo Alto,	Penna.	19
Medical Compound,	J. J. Reeves, .	Sulphur Sp'gs,	Texas,	26
Measuring Liquids,—Appa's for	Hiram James, .	Barclay,	Ill.	5
————————————	John C. Rankin,	Mt. Vernon,	N. Y.	12
Mills, .	Leonard Coleman, .	New Orleans,	La.	12
—— .	E. D. Clark, .	Earlville,	N. Y.	26
—— .	H. C. Velie, .	Poughkeepsie,	"	26
——,—Grinding .	Samuel Moore, .	Wellsburgh,	Va.	12
Millstones,—Dressing .	Joel Bowman, .	Somerset,	Ohio,	5
Millstone Dress, .	J. W. Gaines, .	Melrose,	Texas,	26
Millstones,—Cooling, &c.,	Akins and Babcock, .	Dryden,	N. Y.	12
Mirrors,—Silvering	H. Poissonniér, .	City of	"	19
Mowing Machines, .	Chester Bullock, .	Jamestown,	"	5
Nail-cutting Machine,	Wm. Wickersham,	Boston,	Mass.	26
Neck Stock, .	Wm. Watson, .	Lowell,	Ind.	12
Needles,—Machine for Making	Frederic Plant, .	City of	N. Y.	19
Newspaper File, .	J. N. Jacobs, .	Worcester,	Mass.	19
Oil from Resin,—Distillation of	Samuel Frazer, .	Galena,	Ill.	12
Ores and Coal,—Desulphurizing	Wm. H. Letterman, .	Philadelphia,	Penna.	26
—— of Gold, &c.,—Treating	John McCullock,	San Francisco,	Cal.	26
Paddle Wheel,—Feathering	R. Williams & S. Wilson,	Buffalo,	N. Y.	12
Paints,—Mixing .	S. G. Cheever, .	Boston,	Mass.	5
Paper,—Machine for Wetting	Andrew Overend,	Philadelphia,	Penna.	26
Pegging Machines, .	J. J. Greenough, .	City of	N. Y.	26
Pen and Pencil Case,	G. E. Frew, .	Brooklyn,	"	12
Pen-holder, .	A. F. Warren, .	"	"	19
Photographic Baths,	Wm. and Wm. H. Lewis,	City of	"	26
————— Cameras, .	E. M. Corbett, .	"	"	19
Piano-forte Hammers,—Covers	Jehiel Munson, .	Burlington,	Vt.	19
Picks, .	J. C. Reed, .	Cincinnati,	Ohio,	5
Pitcher,—Beer .	O. Z. Pelton, .	Middletown,	Conn.	19

Pitchers,—Spout and Lid of	David Baker, .	Harwich,	Mass.	19
Planing Warped Surfaces,	John Green, .	Brooklyn,	N. Y.	19
Plane-iron Sharpeners, .	Joshua Turner, .	Cambridgeport,	Mass.	26
Ploughs, .	Whitman Price,	Wayne Co.,	N. C.	5
——— .	C. F. Richter, .	Columbia,	S. C.	5
——— .	R. S. Williams,	Bairdstown, .	Ga.	26
——— .	T. R. Markillie, .	Winchester,	Ill.	19
——— .	Pomeroy & Hudson,	Providence,	R. I.	12
——— .	J. M. Cobb, .	Jackson,	Tenn.	26
———,—Moles for Drain	Hawkins & Puntenney,	Canton,	Ill.	12
——— .	Shipp & Crenshaw, .	La Grange,	Tenn.	26
——— .	J. P. Thompson, .	Jackson,	"	26
———,—Steam .	Albert Bigelow, .	Hamilton,	C. W.	19
———————	L. B. Woolfolk, .	Nashville,	Tenn.	19
——————— .	" .	"	"	26
Plumbers Joints,—Making	J. P. Hayes, .	Philadelphia,	Penna.	19
Porter Bottle Boxes, .	G. W. Righter, .	"	"	5
Post-hole Diggers,	John Lee, .	Bolivar,	Ohio,	26
Preserving Meats, .	G. W. Oliver, .	City of	N. Y.	19
Printing Press, .	M. S. Beach, .	Brooklyn,	"	26
——————— .	G. C. Howard, .	Philadelphia,	Penna.	26
——————— .	Smith & Orvis, .	Oakfield,	Wis.	26
——————— .	A. B. Taylor, .	Newark,	N. J.	26
Presses,—Cotton .	George Milliran,	Byhalia,	Miss.	5
Propeller,—Marine .	D. D. Porter, .	U. S. N.,		12
Prussian Blue, .	James Clark, .	Newark,	N. J.	12
Pumps, .	N. S. Bean, .	Manchester,	N. H.	12
——— .	George Palmer, .	Littlestown,	Penna.	5
———, &c.,—Air Vessels of	A. H. Rauch, .	Bethlehem,	"	5
——— .	Edward Wade, .	Norwich,	Conn.	12
Quartz-crushers, .	Philip Estes, .	Leavenworth,	K. T.	12
Quartz,—Stamping Metal	Gates and Frazer,	Chicago,	Ill.	19
———,—Machines for Crushing	F. N. Du Bois, .	"	"	26
Railroad Car Trucks,—Bolsters	M. C. Andrews, .	Lawrence,	Mass.	5
——— Wheels, .	J. H. Steiner, .	Philadelphia,	Penna.	19
——— Station Indicators,	E. M. & J. E. Woodward,	"	"	26
——— Cars,—Sprinkl'g attach.	Henry Mitchell, .	Cincinnati,	Ohio,	19
Railroads,—Iron Rails for Street	S. A. Beers, .	Brooklyn,	N. Y.	19
Rakes,—Bending Teeth for	Henry Brandt, .	Columbia,	Penna.	5
Reaping and Mowing, .	Daniel Sheets and others,	Suisun City,	Cal.	19
Roofing Houses,—Composition	J. A. Hawley, .	Jackson,	Mich.	5
Roots,—Houses for Preserving	T. V. Bush, .	Gallatin,	Tenn.	5
Rotary Engines, .	T. H. Witherby, .	Worcester,	Mass.	5
——————— .	J. Rix & J. S. Shaw,	Springfield,	Mo.	26
Saccharine Juices,—Evaporating	Gilbert & Ames, .	Bayou Goula,	La.	5
Saddle,—Military .	W. H. Jenifer, .	Baltimore,	Md.	26
Sad-iron Heater, .	W. J. Andrews, .	Columbia,	Tenn.	5
Safes,—Composition for Lining	Jabez Jenkins, .	Philadelphia,	Penna.	19
Sails,—Securing Reef Points of	J. W. Logan, .	"	"	5
Sash-fastener, .	Lafayette Bartoo, .	East Aurora,	N. Y.	19
Sausage-filler, .	J. G. Perry, .	S. Kingston,	R. I.	26
Scroll-sawing Machine, .	W. P. Wood, .	Washington,	D. C.	19
Saws,—Grinding .	Wm. Dougherty, .	Philadelphia,	Penna.	19
——,—Sharpening .	John Armour, .	Helena,	Ark.	5
——,—Tabs for Cross-cut	T. S. Disston, .	Philadelphia,	Penna.	5
Screws and Nuts,—Anti-friction	C. F. Spencer, .	Rochester,	N. Y.	5
———,—Die-plate for Cutting	E. P. Gleason, .	Providence,	R. I.	19
Seats,—Adjustable Carriage	I. L. Vansant, .	Red Lyon,	Del.	19
————————— .	J. A. Naylor, .	Rahway,	N. J.	26
Seed Planters, .	H. C. Fairchild,	Brooklyn,	N. Y.	5
——— .	James Green, .	Kennett Sq.,	Penna.	5

Seed Planters, .	A. J. Rogers, .	Stephentown,	N. Y.	19
——— .	Hervey Sloan, .	Franklin,	Ind.	26
——— .	David Warren, .	Gettysburgh,	Penna.	26
——— .	Elijah Young, .	Fayetteville,	Mo.	26
Seeds,—Planting Cotton	Whitman Price,	Mount Olive,	N. C.	5
———	Benjamin Owen, .	Dayton,	Ohio,	26
———	W. A. and J. F. Suddith,	Charlestown,	Va.	26
Seeding Machines, .	Matthew Mitchell, .	Altona,	Ill.	5
———	M. B. Rupp, .	McVeytown,	Penna.	19
——— .	D. W. M. Lower, .	Albia,	Iowa,	26
——— .	Joseph Sutter, .	City of	N. Y.	26
——— .	Thomas Wilson, .	Winterset,	Iowa,	26
———	Wm. Workman,	Ripon,	Wis.	26
Sewing ——— .	Scofield and Rice, .	Adams,	N. Y.	5
———	W. H. Smith, .	Birmingham,	Conn.	19
——— .	Joseph Geiermann, .	Albany,	N. Y.	19
———	I. M. Rose, .	City of	"	19
——— .	J. S. Steiner, .	St. Louis,	Mo.	19
———	E. S. Yentzer, .	Middletown,	Penna.	19
——— .	J. E. A. Gibbs, .	Mill Point,	Va.	26
———	Austin Leyden, .	Atlanta,	Ga.	26
——— .	Fr. Toggenburger, .	Chicago,	Ill.	26
———,—Guides for	Wm. Price, .	City of	N. Y.	19
——— ———	Wm. Rankin, .	Richmond,	Va.	19
———,—Hemmers	W. P. Mitchell,	Baltimore,	Md.	26
———,—Marking in	H. W. Fuller, .	Brooklyn,	N. Y.	5
———,—Shuttles	George Juengst,	City of	"	26
———,—Starting	T. J. Alexander, .	Westerville,	Ohio,	12
Shingle Machines, .	McLean and Grummer,	Indianapolis,	Ind.	5
———	J. D. Chism, .	Albany,	N. Y.	12
——— .	E. T. Wheeler, .	Cannelton,	Ind.	19
Shingles from Bolt,—Sawing	J. M. Carlisle, .	Greenwood,	S. C.	19
Ships Windlass, .	A. I. Gove, .	San Francisco,	Cal.	12
Shoe Tips,—Cutting Blanks for	G. A. Mitchell, .	Turner,	Me.	26
———,—Swaging .	" .	"	"	26
Shutter Operator,	Chas. Seltman, .	Washington,	D. C.	26
Skirt Hoops, .	Stokes & Jones,	City of	N. Y.	12
Skirts,—Making Hoop	Cæsar Newman, .	"	"	26
———,—Manufacturing Skeleton	F. S. Otis, .	Brooklyn,	"	5
———,—Skeleton .	S. S. Sherwood, .	City of	"	26
Sleighs,—Attach. Whiffletrees to	A. P. Hutchinson,	Pembroke,	N. H.	26
Spoke Machines, .	Stam and Shubert, .	Sardinia,	Ohio,	19
Spring Balances, .	Wm. A. Crowell,	Salisbury,	Conn.	26
———,—Door .	Jacob Post, .	Newark,	N. J.	12
Springs,—Car .	Richard Vose, .	City of	N. Y.	5
——— .	" .	"	"	12
———,—Tempering Steel	C. G. & H. M. Plympton,	Walpole,	Mass.	5
Stave Machine, .	Wm. Trapp, .	Elmira,	N. Y.	12
Steam Boiler, .	J. S. Colvin, .	Pittsburgh,	Penna.	12
——— Boilers, .	M. R. Clapp, .	Seneca Falls,	N. Y.	12
———,—Alarm Gauge	E. A. Kimball, .	Boston,	Mass.	19
———,—Explosion of	H. L. Justice, .	Nashville,	Tenn.	12
———,—Feed-water	Ephraim Pierce,	Cincinnati,	Ohio,	12
———	Wm. C. Drum, .	Bellevernon,	Penna.	26
——— Engines,—Reg. Exhaust	James Thierry, .	Detroit,	Mich.	26
———,—Slide Valves	E. M. Lewis, .	Philadelphia,	Penna.	12
——— Pressure Gauge, .	Wm. H. Allen, .	Brooklyn,	N. Y.	19
——— Radiators,	A. P. Pitkin, .	Hartford,	Conn.	12
——— Stuffing-box for Rolls,	Hugh Campbell,	Newtown,	"	12
——— Trap, .	C. C. Walworth, .	Boston,	Mass.	19
——— Valve, .	Leopold Bennett,	Pittsburgh,	Penna.	5
Steering Apparatus,	A. D. Rollins, .	Green Point,	N. Y.	19
Stills, .	S. Godfrey and others,	Fairfield,	Ohio,	26

Stop-cocks, .	Robert Nicoll, .	City of	N. Y.	5
Stoves, .	W. H. Smith, .	Newport,	R. I.	19
——,—Cooking	S. S. Jewett, .	Buffalo,	N. Y.	12
—— .	A. S. Sterling, .	"	"	19
Stump Extractors,	A. Broughton, .	Malone,	"	19
—— .	John Hamlyn, .	Bellevue,	Mich.	26
——	Nathan Parish, .	Galesburgh,	"	26
Sugar,—Clarifying .	H. G. C. Paulson,	City of	N. Y.	19
——,—Machine for Cutting	T. H. Quick, .	"	"	26
Sulphurous Acid,—Manufac. of	Marcelin & Eude,	New Orleans,	La.	12
Table Plate, .	D. H. Shirley, .	Boston,	Mass.	12
Tin Boxes,—Making	C. J. Haywood, .	Durham,	Conn.	5
Tires,—Heating Wagon	I. N. Whitaker, .	Foreston,	Ill.	12
——,—Upsetting .	Henry Barringer,	Wataga,	"	19
Tobacco Press, .	John Sweeney, .	Chicago,	"	26
Tooth Brush, .	H. N. Wadsworth,	Washington,	D. C.	19
Torch for Night Processions,	Isaac Edge, .	Jersey City,	N. J.	12
Torches,—Gas .	G. C. Brower, .	New Orleans,	La.	5
Trap,—Animal .	Wm. Wright, .	Philadelphia,	Penna.	19
Tubes,—Coat. for inter. of metal	John Matthews, Jr.,	City of	N. Y.	5
Turbine Wheels,—Hanging	A Warren & E Damon, Jr.,	Boston,	Mass.	5
Tweer, .	Marvin Mead, .	Bedford,	Mich.	12
Type,—Setting, .	Henry Harger, .	Delhi,	Iowa,	26
——,—Scouring .	J. G. Pavyer, .	St. Louis,	Mo.	26
Typography, .	Villet-Collignon & George,	Paris,	France,	12
Ventilation of Casks, .	Louis Wilhelm, .	Buffalo,	N. Y.	19
Vehicles,—Shafts to two-wheel	H. M. Walker, .	Watertown,	Conn.	19
Vulcanizing Rubber, .	G. E. Hays, .	Buffalo,	N. Y.	12
Washboard, .	Isaac Cook, .	Mt. Pleasant,	Iowa,	5
Washing Machine, .	H. Ehrman and others,	Annville,	Penna.	5
——	J. W. Crane, Jr., .	Freeport,	Ill.	12
—— .	P. Z. Allen, .	Knox,	N. Y.	26
Watch Chains, .	C. B. Carpenter, .	N. Attleboro',	Mass.	19
—— Chain Hook, .	E. N. Foote, .	City of	N. Y.	26
—— Key and Guard Bar,	D. F. Elmer, .	Haydenville,	Mass.	26
Watches,—Constructing Rims	C. W. Clewley, .	Providence,	R. I.	19
Water Closets, .	Thomas Grundy, .	Boston,	Mass.	26
—— Elevators, .	John Champlin,	E. Middlebury,	Vt.	26
—— in Pipes,—Reg. pressure	James Stratton, .	Brooklyn,	N. Y.	5
—— Wheel, .	A. Morehouse, .	Farmer,	"	12
—— Wheels, .	Caleb Bond, .	Richmond,	Ind.	26
Weighing and Bagging Grain,	J. M. Fish, .	Buffalo,	N. Y.	5
Willows, &c.,—Removing Bark	L. A. Beardsley, .	S. Edmeston,	"	26
Window Blinds, .	C. W. Smith, .	Evans,	"	26
—— Curtain,	G. L. Kelty, .	City of	"	5
Windmills, .	Walter Peck, .	Rockford,	Ill.	19
Wire Rope,—Making	Cornelius Collins, .	Brooklyn,	N. Y.	19
Wood and Metal,—Finishing	George Stover, .	New Britain,	Conn.	19
Wrench, .	A. T. Gove, .	San Francisco,	Cal.	12

EXTENSIONS.

Dredging Machines, .	Carmichael & Osgood,	Brooklyn,	N. Y.	5
Stoves,—Cooking	R. D. Granger, .	Albany,	"	12

ADDITIONAL IMPROVEMENTS.

Cakes,—Cutting and Panning	J. H. Shrote, .	Baltimore,	Md.	26
Molding Machines, .	E. M. Smith, .	Shelbyville,	Ind.	26
Quartz,—Crushing	J. C. Dickey, .	Saratoga Sp'gs,	N. Y.	12
Skates to Boots,—Attaching	T. S. Whitman, .	City of	"	19
Steering Apparatus, .	Daniel Jones, .	Boston,	Mass.	26
Tile,—Laying Drain	B. B. Briggs, .	Sharon,	Ohio,	26

RE-ISSUES.

Corn-shellers,	Nathaniel Drake,	Newton,	N. J.	12
Grass,—Machines for Cutting	C. H. McCormick,	Chicago,	Ill.	5
————	"	"	"	5
————	"	"	"	5
Hair Brush Handles,—Finishing	Thomas Mitchell,	Lansingburgh,	N. Y.	26
Harvesters,—clover & grass seed	W. N. Whitely, Jr.,	Springfield,	Ohio,	19
————	"	"	"	19
————	"	"	"	19
————,—Grain & Grass	Jacob Swartz,	Buffalo,	N. Y.	5
————	Cyrenus Wheeler, Jr.,	Poplar Ridge	"	5
Hose Pipe,—Coating for	N. Y. Rubber Company,	City of	"	5
India Rubber,—Vulcanizing	J. P. Trotter,	"	"	19
Lenses,—Fluid	Seligman Kakeles,	"	"	26
Reaping & Mowing Machines,	C. H. McCormick,	Chicago,	Ill.	5
————	"	"	"	5
————	"	"	"	5
Reflector,—Night-light	John Wyberd,	City of	N. Y.	12
Skeleton Hoop Skirts,	Cæsar Newmann,	"	"	26
Railroad Cars and Carriages,	P G. Gardiner,	"	"	12
Steering Apparatus,	Wm. Godsoe,	Manchester,	Mass.	12
Water-closet,	Wm. S. Carr,	City of	N. Y.	12
Water Wheel,	J. P. Collins,	Troy,	"	12
Window Stop,	Williams & Heaton,	Providence,	R. I.	12

DESIGNS.

Bust of Abraham Lincoln,	L. W. Volk,	Chicago,	Ill.	12
Carpet Patterns,	E. J. Ney,	Lowell,	Mass.	12
——— Pattern (11 cases),	H. G. Thompson,	City of	N. Y.	19
Carpets,	E. J. Ney,	Lowell,	Mass.	12
Decanter Stoppers,	Wm. Pountney,	City of	N. Y.	19
Fire Shovel (4 cases),	Lemuel Morgan,	S. Norwalk,	Conn.	19
Nut-cracker,	S. G. Smith,	City of	N. Y.	12
Pump,	Birdsill Holly,	Lockport,	"	19
Range,—Cooking	A. C. Barstow,	Providence,	R. I.	12
———,—Cook's	Gardiner Chilson,	Boston,	Mass.	12
Roofs,—Ornamental Ridge	J. L. Jones,	Slatington,	Penna.	12
Stove,	S. W. Gibbs,	Albany,	N. Y.	12
——,—Cook's,	N. S. Vedder,	Troy,	"	12
——,—Cooking	R. H. N. Bates,	Providence,	R. I.	12
——,—Parlor	Louis Meyer,	St. Louis,	Mo.	19

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, August 20, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Society of London, and from the State Librarian of Pennsylvania, Harrisburgh, Penna.

Donations to the Library were received from the British Government, the Royal Society and the Statistical Society, London; the Royal Cornwall Polytechnic Society, Falmouth, England; the Nieder-Osterreichischen Gewerbe Vereines, Vienna, Austria; the Smithsonian Institution, and the Hon. P. F. Thomas, Commissioner of Patents, Washington, D. C.; the Maryland Agricultural College, Prince George's County, Maryland: Wm. J. Lewis, Esq., San Francisco,

California; Dr. Chas. M. Wetherill, Lafayette, Indiana; Messrs. Little, Brown & Co., Boston, Mass.; Messrs. C. W. Eliot and F. H. Storer, Cambridge, Mass.; J. S. Homans, Esq., and the Mercantile Library Association of the City of New York; the Mercantile Library Association of Brooklyn, New York; and Prof. John F. Frazer, Philada.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statements of the receipts and payments for the months of June and July were read.

The Board of Managers and Standing Committees reported their minutes.

Four resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (12) were proposed, and the candidates proposed at the last meeting (5) duly elected.

Mr. Howson exhibited a specimen of a hand-saw manufactured by Mr. H. Disston, of the "*Keystone*" Saw Works of this city.

In form and weight it differed but little from hand-saws of ordinary construction; it is, however, by its peculiar construction, rendered available as a rule, a square, a level, and a plumb-rule. On the handle of the saw are formed two shoulders at right angles to the back edge of the blade, thus converting the instrument into a square. In the handle are let two spirit tubes, one being placed at right angles to, and the other parallel with the back edge of the blade, so that the latter can be applied as a level or plumb-rule, the blade itself being graduated into feet and inches for ordinary measuring purposes.

Mr. Howson also exhibited a specimen of fractured brass submitted by Mr. T. Shaw, of this city. The specimen consists of a disk, three inches in diameter and about one-fourth of an inch thick, with a central hub on one side. The fracture (which appears to have taken place while the metal was being turned in a lathe) consisted of the entire separation of a piece varying from one-thirty-second to one-sixteenth of an inch in thickness from the main body of the disk, the fracture being nearly in a plane parallel with the face of the disk.

The President remarked that although the specimen was a curious one, such fractures were not unusual; that it was no doubt owing to some hesitation in pouring the molten metal into the mould, an opinion concurred in by members present.

Mr. H. also exhibited a specimen of a boot, the leg and foot of which was made of one piece of leather folded together and presenting a single seam. The specimen was submitted by Mr. Michael Fritz, No. 1218 Whitehall St., the agent in this city for the inventor and patentee, Mr. Peter Keffer, of Reading, Pa.

The inventor says a pair of boots can be made after this manner in the time it takes to crimp the leather in the old way, and prevents the strain on the uppers to which crimping subjects them.

Mr. George Munro exhibited a specimen of a shoe made for a deformed foot, and illustrated the advantages of his mode of forming lasts from casts made from the foot.

BIBLIOGRAPHICAL NOTICE.

The Institutes of Medicine. By MARTYN PAINE, A. M., M. D., LL. D., Professor of the Institutes of Medicine and Materia Medica in the University of the City of New York, &c.: Fifth Edition—New York, Harper & Brothers.

The Institutes of Medicine treats of those broad principles of science concerned in the development, preservation, and perfection of the living organism. It includes more especially those particular branches of medical science known as physiology, pathology, hygiene, and therapeutics, and constitutes, in fact, the philosophy of medicine. Its object is to thus determine the laws of health and disease, and point out the means of preserving the former, and resolving as well as preventing the latter. In the work before us, an elaborate effort has been made to unfold these great principles of medical philosophy, yet, notwithstanding its author is one of the most erudite and accomplished medical writers of the day, the doctrines taught therein are now generally regarded as representing the knowledge of the past rather than of the present. Nevertheless, this work contains so much useful information upon the subject of which it treats as to render it very valuable, not only to physicians but to all others interested in medicine. Z.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

JULY.—The temperature of the month of July was a little more than one degree below the average for the last ten years, and a little less than one degree higher than that of July of last year. The warmest day was the 20th, of which the mean temperature was 87·7°, and the thermometer was highest on the same day, indicating a maximum temperature of 95½°. The coldest day was the 6th of the month, of which the mean temperature was 64·2°. The thermometer was lowest on the morning of the 7th, giving the minimum for the month 57°. The oscillations of temperature and the mean daily range of the thermometer were considerably greater than usual, though very nearly the same as for the month of July last year.

The pressure of the atmosphere was less than usual, the barometric column standing five-hundredths of an inch lower than the average of the month for ten years. The minimum (29·495 inches) occurred on the afternoon of the 5th, and the maximum (29·979 inches) on the morning of the 28th, showing for the whole month a range of less than half an inch. The only approach to a storm that happened during the month, occurred early on the morning of the 27th, and was very severe in the northern part of the city and the neighboring counties, where the lightning, which was very vivid, struck in several places. The wind was high, and the rain is said to have fallen in unusual quantities. In

the centre of the city less than two-tenths of an inch of rain fell on that morning.

The number of days on which rain fell was about the same as usual, but the quantity falling at each time was very small, in no case exceeding three-tenths of an inch. The quantity that fell during the whole month was less than seven-eighths of an inch, and less than has fallen during any July for the last ten years. The next lowest amount was in July, 1856, when an inch and one-eighth fell.

There was not one day of the month entirely clear, and but two days on which the sky was completely covered with clouds at the hours of observation.

The force of vapor and relative humidity for the month still continued considerably below the average, both for the last year and for the last ten years.

The atmosphere on the 18th was very favorable for observing the eclipse of the sun, which happened on the morning of that day. The following meteorological observations taken every ten minutes during its continuance may be useful for comparison.

Meteorological Observations during the Eclipse, July 18*th*, 1860, *at Philadelphia.*

	Thermometer.	Relative Humidity.	Force of Vapor.	Dew Point.	Barometer at 32° F.	Wind.	Clouds.		
							Sky covered.	Course.	Description.
	°	Per ct.	Inch.	°	Inch.	Direc.			
A. M., 6 h. 30 m.	72	62	·486	58·2	29·890	E N E	·3		Stratus, Haze.
40	73	58	·472	57·4	29·900	N E.	·3		" "
50	73	58	·472	57·4	29·920	N E.	·4		" "
7 h. 00 m.	74	59	·493	58·6	29·928	N E.	·4		" "
10	75½	56	·490	58·4	29·948	N E.	·4		" "
20	75	55	·479	57·8	29·948	N E.	·3		" "
30	75½	56	·490	58·4	29·938	N N E.	·3		" "
40	75½	57	·507	59·4	29·937	N E.	·3		" "
50	76	54	·483	58·0	29·937	N E.	·3		" "
8 h. 00 m.	76	56	·501	59·0	29·947	N E.	·3		" "
10	75½	57	·507	59·4	29·945	N E.	·2		Haze.
20	76	58	·518	60·0	29·945	N E.	·4		Cirrus, cir-st., Haze over Sun.
30	76½	58	·530	60·6	29·945	N E.	·4	N W.	" " Haze.
40	77	56	·523	60·3	29·945	N E.	·6	WNW	" " Cir-cu, Haze.
50	78½	55	·539	61·1	29·945	N E.	·6	N W.	" " Haze.
9 h. 00 m.	80	51	·518	60·0	29·945	N E.	·5	WNW	" " "
10	81	49	·523	60·2	29·954	N E.	·6	WNW	" " "
20	81½	50	·535	60·9	29·962	E N E.	·6	WNW	" " "

On the evening of the 20th, the warmest day of the month, about half past nine o'clock, a very extraordinary meteor appeared in the sky. It arose in the north-western part of the heavens, from a cloud which was made visible by the light of the meteor, from 25° to 30° above the horizon. Then an object, apparently about the size of the full moon, and as bright, suddenly starting from the cloud, traversed in an easterly direction the whole extent of the northern sky; sending off what appeared like sparks until it passed very far to the eastward, when it disappeared behind a cloud, at about the same distance from the horizon as that from which it started. The whole flight from west to east occupied a little less than a minute of time. Soon after leaving the edge of the cloud from which it started, it appeared to separate

into two parts of similar appearance, the smaller one closely following the larger and appearing as if connected with it by a band of light. Observers differ in regard to the height at which it passed the meridian, though the majority of those with whom I have conversed agree that it must have been at least 10° below the polar star. Its height at the meridian appeared to be very nearly the same as that at which it first appeared, giving the idea of a body moving in the direction of a tangent to the curvature of the earth's surface. It has been supposed from a comparison of observations made at many places, that the path of the meteor was vertical about 110 miles north of Philadelphia, passing over the northern part of Pennsylvania, in a nearly easterly course, over or near the north part of New Jersey, the south-west corner of the State of New York and Long Island Sound. If this supposition is correct, it must have been between 63 and 64 miles above the earth's surface in the meridian of Philadelphia. It pursued its course across the ocean, being seen many miles out at sea, and perhaps passed beyond the influence of the earth and resumed its original character of a wanderer in the planetary spaces. These are the results of our present information in regard to this stranger. Further and more accurate observations may somewhat modify the conclusions arrived at in regard to its precise position in our system.

A Comparison of some of the Meteorological Phenomena of July, 1860, *with those of July*, 1859, *and of the same month for ten years, at Philadelphia.*

	July, 1860.	July, 1859.	July, 10 years.
Thermometer.—Highest, . .	95½°	97°	100½°
" Lowest, . .	57	54	53
" Daily oscillation,	19·80	20·20	15·90
" Mean daily range,	5·00	4·60	3·80
" Means at 7 A. M.,	72·50	72·00	74·10
" " 2 P. M.,	83·89	82 68	83·93
" " 9 P. M.,	74·34	73·31	76·78
" " for the month,	76·91	76·00	78·27
Barometer.—Highest, . .	29·979 in.	30·212 in.	30·212 in.
" Lowest, ...	29·495	29·554	29·443
" Mean daily range, .	·112	·099	·094
" Means at 7 A. M., .	29·811	29·870	29·861
" " 2 P. M., .	29·774	29·833	29 831
" " 9 P. M., .	29·787	29·853	29·846
" " for the month,	29·791	29·852	29·846
Force of Vapor.—Means at 7 A. M.,	·539 in.	·551 in.	·618 in.
" " " 2 P. M.,	·505	·574	·618
" " " 9 P. M.,	·559	·579	·645
Relative Humidity.—Means at 7 A. M.,	67 per ct.	69 per ct.	73 per ct.
" " " 2 P. M.,	43	51	53
" " " 9 P. M.,	65	69	70
Rain, amount in inches, . .	0·851	3·915	3·820
Number of days on which rain fell, .	10	11	10
Prevailing winds, ...	S.70°1′W. ·135	N.84°6′W. ·166	S.64°17′W ·123

Abstract of Meteorologi *June, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties,*
e Committee on Meteorology of the Franklin Institute.

—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 60 feet. Prof. J. A. Kirkpatrick, Observer.

1860. June.	Barometer. Mean.	Barometer. Mean daily range	Thermometer. Mean.	Thermometer. Daily oscil-lation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
1	29·678	·056	67·3	13	5·0	·488	64		N W.
2	29·735	·063	70·7	21	4·0	·331	32		N W.
○ 3	29·691	·051	73·3	21	4·0	·375	37		S W.
4	29·457	·234	69·0	16	4·3	·514	60	0·670	S E.
5	29·287	·170	65·3	11	5·7	·576	84	0·100	S E.
6	29·469	·181	67·7	14	2·8	·520	66	1·400	W.
7	29·492	·025	71·0	17	3·3	·424	43		N W.
8	29·499	·032	66·7	19	2·3	·362	37	0·180	W.
9	29·522	·039	68·1	13	4·8	·362	51		N W.
10	29·557	·065	66·0	19	2·5	·433	54		N W.
☾ 11	29·691	·104	69·0	21	5·0	·235	26		N W.
12	29·807	·116	73·2	29	4·2	·294	25		N W.
13	29·536	·037	74·7	25	2·2	·514	46		S W.
14	29·830	·042	75·5	24	0·8	·426	37		S W.
15	29·835	·033	75·3	21	0·5	·440	30		S W.
16	29·833	·008	70·3	17	5·0	·606	70	0·070	W.
17	29·874	·041	68·0	10	3·3	·662	79	0·525	(var.)
18	29·840	·039	70·7	18	5·0	·511	49		S E.
● 19	29·641	·199	70·2	16	3·8	·611	68	0·670	S S W.
20	29·596	·066	72·2	19	3·7	·524	52		N W.
21	29·838	·231	60·0	13	12·2	·388	66		N E.
22	29·929	·109	60·7	16	6·7	·321	41		N E.
23	29·964	·025	71·8	28	5·2	·410	40		N E.
24	30·062	·127	70·3	21	1·5	·356	36		E N E.
☽ 25	30·102	·040	71·8	25	2·2	·375	37		N N E.
26	29·978	·124	80·2	29	5·8	·494	38		W.
27	29·926	·040	80·7	15	7·2	·577	50		N W.
28	29·671	·067	80·5	20	6·6	·458	30		(var.)
29	29·650	·221	82·2	19	8·3	·717	48	0·331	W S W.
30	29·683	·064	85·3	19	3·6	·776	53		W.
Means	29·740	·086	71·7	19	4·2	·464	48	3·706	N 67° W

Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.

1860. June.	Barom. Mean.	[redacted] Mean.	Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·109	62·3	7·7	·399	63		S E.
2	29·189	68·0	9·0	·326	37		W.
3	29·101	66·7	2·3	·476	59	0·070	W.
4	28·772	69·3	4·0	·524	51		W.
5	28·645	68·0	4·8	·598	76		W.
6	28·648	70·0	2·0	·505	56	0·834	W.
7	28·855	69·7	2·3	·489	62		W.
8	28·861	68·8	3·3	·331	39	0·090	W.
9	28·944	62·7	5·7	·502	79		W.
10	29·011	64·3	2·3	·358	46		W.
11	29·092	65·7	3·7	·305	34		W.
12	29·167	71·3	4·7	·369	42		W.
13	29·187	75·8	4·0	·382	37		W.
14	29·212	73·0	2·3	·501	51		E.
15	29·204	73·3	0·3	·452	44	0·060	E.
16	29·207	66·3	3·8	·516	84		E.
17	29·236	70·0	0·3	·614	65		E.
18	29·223	72·7	2·7	·524	61		E.
19	28·974	73·0	1·7	·497	46	0·045	W.
20	28·976	70·7	4·3	·532	63	0·040	W.
21	29·186	65·0	5·7	·516	64		(var.)
22	29·310	64·3	2·7	·390	56		N E.
23	29·330	70·8	6·0	·470	52		N E.
24	29·473	72·7	3·0	·417	41		E.
25	29·514	70·0	2·7	·470	52		E.
26	29·408	76·3	6·2	·650	64		(var.)
27	29·339	75·7	5·7	·627	86	0·220	(var.)
28	29·256	79·3	3·7	·687	62		(var.)
29	29·063	81·7	3·0	·809	59		(var.)
30	29·154	80·0	3·7	·803	71		S.
Means	29·104	70·6	4·2	·489	57	1·350	N 82° W

Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs. — Freeport, Armstrong Co. 40° 44′ N. 79° 42′ W. Height, 1000 feet. J. H. Baird, Obs.

1860. June.	Indiana Thermom. Mean.	Indiana Thermom. Mean daily range.	Indiana Rain.	Indiana Prevail'g winds.	Freeport Thermometer. Mean daily range.	Freeport Prevailing winds.
	°	°	Inch.	Direc.	°	Direc.
1	55·8	12·3		N W.	10·7	(var.)
2	62·3	7·0		N W.	6·7	N W.
3	50·0	6·7		(var.)	8·0	?
4	67·0	8·0	0·310	(var.)	7·0	S W.
5	63·0	4·7	0.160	S W.	9·3	N W.
6	64·0	2·3	0.360	N W.	2·7	?
7	55·7	1·7	0.180	W.	2·3	W.
8	58·7	9·0	0.760	N W.	3·7	W.
9	53·0	5·7		N W.	5·0	N W.
10	58·8	2·7		N.	5·0	(var.)
11	63·7	6·7		N W.	6·3	W.
12	71·3	9·0		N W.	6·7	E.
13	75·3	5·3		E.	0·7	S.
14	76·0	2·7		S E.	3·7	S.
15	74·3	1·7		S W.	3·3	W.
16	64·3	6·0	0·380	N.	4·0	N.
17	68·3	6·7		N.	2·3	E.
18	72·3	4·0		(var.)	4·7	?
19	69.7	4·7		S W.	3·7	W.
20	66·7	3·7		W.	3·0	N.
21	68·3	1·7	0·140	N W.	2·3	N W.
22	67·0	3·3		E.	3·7	E.
23	65·7	6·3		E.	6·3	?
24	74·1	6·0		E.	6·3	?
25	74·7	0·7		S W.	2·0	N W.
26	76·3	4·0		S W.	3·0	N W.
27	76·0	6·0		W.	5·7	W.
28	76·7	4·7		(var.)	7·7	W.
29	75·3	3·3	0·220	W.	6·0	S W.
30	74·7	0·7		N W.	3·7	W.
Means	[redacted]	4·9	2·530	N 65° W	5·0	N 60° W.

Abstract of Meteorological Observations for June, 1860; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

GETTYSBURG, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. JACOBS, Obs.

1860. June.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	[redacted]	Prevail'g winds.
	Inch.	°	°	Inch.	Direc.
1	29·336	62·0	8·7	0·010	N W.
2	29·446	65·0	9·3		N W.
○ 3	29·296	64·8	4·3	0·095	S W.
4	28·960	67·0	3·3	1·820	S W.
5	28·542	64·0	5·0	0·196	N W.
6	29·065	69·7	5·7	0·040	(var.)
7	29·087	69·0	1·3	0·010	N W.
8	29·096	66·0	3·0	0·008	(var.)
9	29·202	60·8	5·3		N W.
10	29·227	64·0	3·3		N W.
☾ 11	29·330	68·3	4·3		N W.
12	29·412	71·0	2·7		S W.
13	29·436	72·0	1·7		S.
14	29·442	72·3	1·0		S S E.
15	29·427	72·3	2·0		(var.)
16	29·442	62·0	7·7	0·102	(var.)
17	29·487	69·3	3·0		N W.
18	29·471	78·3	4·3		(var.)
● 19	29·234	70·3	1·7	0·210	S W.
20	29·206	71·0	3·0	0·109	N W.
21	29·423	68·3	7·7	0·005	N E.
22	29·569	64·0	3·3		N N E.
23	29·572	70·3	6·3		(var.)
24	29·716	71·7	1·3		(var.)
☽ 25	29·746	70·3	2·0		(var.)
26	29·626	77·7	7·3		S W.
27	29·556	76·7	5·3	0·080	(var.)
28	29·495	79·0	5·7	0·020	S W.
29	29·250	82·3	3·3		W S W.
30	29·321	81·0	2·0		S W.
Means	29·340	69·7	4·4	2·784	[redacted]79° W.

HARRISBURG, Dauphin Co. 40° 16′, N. 76° 50′, W. Ht., 300 ft. JOHN HEISELY, M.D., Obs.

June.	Barom.	Thermom.	Prevail'g winds.
			Direc.
1			l W.
2			W.
3			W.
4			N E.
5			W.
6			t W.
7			W.
8			W.
9			l W.
10			l W.
11			N.
12			S W.
13			S.
14			S.
15			S.
16			N.
17			
18			S W.
19			var.)
20			N E.
21			N E.
22			var.)
23			W.
24			S.
25			S.
26			S W.
27			W.
28			W.
29			W.
30			W.
Means			West.

SHAMOKIN, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. FRITZ, Obs.

June.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Prevail'g winds.
		°	Inch.	Direc.
1		9·0		(var.)
2		8·0		(var.)
3		2·0		W.
4		2·3	0·400	(var.)
5		4·0	1·061	(var.)
6		4·3		W.
7		2·3		W.
8		3·7	0·066	W.
9		3·7		W.
10		2·3		(var.)
11		12·0		W.
12		4·7		W.
13		3·3		W.
14		1·7		W.
15		2·3	0·070	W.
16		14·7	0·675	E.
17		7·0	0·016	E.
18		1·7		N W.
19		5·7	1·200	S E.
20		6·6		W.
21		2·3		S E.
22		2·7	0·073	(var.)
23		6·0		W.
24		6·7		W.
25		4·7		S W.
26		10·3		N W.
27		6·7		W.
28		10·7	0·050	(var.)
29		7·3	0·200	(var.)
30		6·7		W.
Means	66·6	5·0	4·461	West.

FLEMING, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. BRUGGER, Obs.

June.	Thermom. Mean.	Thermom. Mean daily range.	Rain.	Prevail'g winds.
	°	°	Inch.	Direc.
1	58·0	7·7	0·066	W.
2	67·0	6·7		W.
3	63·0	4·0		W.
4	63·7	1·3	1·736	W.
5	64·0	3·7	0·420	(var.)
6	66·0	3·3		(var.)
7	64·0	2·0	0·100	W.
8	62·0	2·0	0·160	N W.
9	58·3	4·3	0·020	N W.
10	50·3	5·7		N W.
11	64·0	4·7		N W.
12	70·7	6·7		(var.)
13	71·0	1·0		(var.)
14	72·0	1·7		S W.
15	72·3	2·3		W.
16	64·0	8·3	1·220	(var.)
17	67·3	4·7		W.
18	70·0	2·7		(var.)
19	70·0	4·0	0·340	W.
20	67·0	3·0		W.
21	66·0	3·0	} 0·500	S E.
22	62·3	6·3		E.
23	68·0	6·7		E.
24	70·3	3·3		S E.
25	71·3	2·3		S E.
26	76·0	3·7		W.
27	74·3	6·0	0·740	W.
28	71·7	4·7	0·360	W.
29	75·3	4·3	0·200	W.
30	71·3	4·0		W.
Means	67·8	4·0	5·840	[redacted]° W.

SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.

June.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	27·650	52·7	10·3	·355	84	0·024	W.
2	27·749	58·0	6·0	·384	52		W.
3	27·577	60·0	4·0	·393	59	0·115	E.
4	27·264	65·7	6·3	·650	66	0·546	(var.)
5	27·222	60·7	5·0	·443	65	0·299	W.
6	27·305	60·0	5·3	·504	56	0·167	W.
7	27·406	61·0	5·0	·450	67	0·120	W.
8	27·428	60·7	0·3	·411	60	0·162	W.
9	27·553	60·8	10·3	·376	93	0·193	W.
10	27·610	63·0	4·0	·270	47		N W.
11	27·673	68·3	6·0	·389	50		(var.)
12	27·096	66·0	7·7	·546	52		S E.
13	27·606	67·7	7·0	·549	57		E S E.
14	27·717	66·7	4·3	·493	49		S E.
15	27·704	70·0	5·3	·557	49		S E.
16	27·718	61·3	8·7	·419	68	0·011	S E.
17	27·748	65·7	4·3	·435	48		E N E.
18	27·722	60·7	6·0	·608	46		(var.)
19	27·546	67·3	5·0	·620	55	0·207	W.
20	27·651	63·3	4·0	·476	56		W.
21	27·662	64·0	0·7	·531	63	0·240	(var.)
22	27·780	57·0	7·0	·409	65		(var.)
23	27·843	62·3	6·0	·401	45		(var.)
24	27·892	66·7	4·3	·571	62		S E.
25	27·928	71·0	4·3	·577	40		W.
26	27·905	71·0	9·0	·636	61		W.
27	27·832	71·3	5·3	·657	68	0·101	W.
28	27·760	75·3	4·7	·554	62	0·263	(var.)
29	27·614	75·3	3·3	·670	58	0·036	W.
30	27·062	72·0	8·8	·771	78	0·430	W.
Means	27·640	64·3	5·2	·513	59	3·164	S 60° W.

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CIVIL ENGINEERING.

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*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M.A., F.R.S.

(Continued from page 163.)

The question then arises how these things are to be overcome in our climate. Generally speaking, one would be apt to suppose that non-absorbency was a most desirable thing; and that if we could render stones non-absorbent—that is, if we could prevent them from sucking in the moisture and these dangerous gases—we should be able to answer our purpose and prevent the decay of the stone. I need not inform you that it is no new thing to preserve in this way—not, indeed, stone—but other substances, such as stucco and terra cotta. You can scarcely go into a good modern street in London without seeing a large number of houses covered over with cement, and that cement covered over with paint. Now, what is paint? It is a mixture of oil and oxide of lead. The paint coats the surface in such a way that water cannot get into it. We all know the result; the paint, indeed, never looks well; it is not an ornamental thing under ordinary circumstances, and much less so when applied to stones. But how far is it successful? Why, the moment it is put on, it begins to decay. Decay must take place, because oil begins to decompose the moment it is exposed to the action of the air; and the result is, that after a very short time the oil separates from the oxide of lead, and the surface first blackens

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and soon begins to peel off. You have a thin film of oil and white lead put on a surface; it adheres slightly for a time, but the moment it is left alone it begins to decompose and rot, and in the course of a year or two you must do all the work over again. Numerous plans have been patented for coating and choking the pores of absorbent stones with preparations of various kinds. The almost invariable idea has been, to render the stones as far as possible non-absorbent. This has been done by combining a certain proportion of mineral substance with oil or fatty matters. There is but one observation with regard to these; they all inevitably tend to decomposition except, perhaps, those that are of a pitchy or bituminous nature.

Bitumen is of a nature that does not decompose by exposure, and is permanent, but it is of so dark and disagreeable a color that it completely destroys the appearance of stone, and renders it so unsightly that no one could venture to recommend it. Oil and fatty substances, therefore, are the only ones that have been used. One cannot help feeling, that if our stone buildings are to be painted till their character as stone is lost, it would be better to build them of cheaper material and use bricks and stucco at once. I may say with regard to the patents that have been taken out within the last 20 years on subjects of this kind, that I have had no less than 17 before me, and out of these 17, 11 are simply mixtures of various substances with oils and resins, and are therefore essentially of the same nature. Some of the others use mixtures of mineral matters in oil, but none of them appear to have answered the purpose, and none of them are now employed at all. There is another point I ought to mention, and that is, that a mere mixture of things not involving chemical combination, must fail. We must then either have some invention by which the pores of stones are permanently choked by a bituminous substance, not unsightly, and not in any way subject to decomposition, or we must find some mineral deposit which we can answer for, which will adhere firmly and which will also be permanent; in other words, we must put something into or upon the stone which shall be a mineral substance, closely adhering and not subject to ordinary atmospheric influences.

It is now many years since a suggestion was made by a French chemist, of the name of Kuhlman, which was apparently very ingenious, and which to a certain extent, answered the purpose. It was a suggestion to coat the surface of absorbent stones with silica. Now, I have already spoken to you of silica as forming the great mass of sandstones, and also, to a great extent, the base of granite. Common flint is the form in which we all know it. In that form it appears to be rather an unpromising suggestion to apply it to a surface in such a way that it shall adhere and be permanent. Silica, which is in fact a combination of a base which is called *silicon* with oxygen, is also called by chemists *silicic acid*, but the acid properties are so weak that they cannot be recognised by the senses, and its affinities for alkaline bases are very feeble. Silicic acid, or silica, is capable of existing in combination with water, and in combination with some alkalies is soluble; is found in nature, combined with water, in some minerals, and

when in that state is passed into a state of insolubility by the action of alkaline carbonates, among the rest carbonate of lime.

As a natural hydrate, or combined with a small quantity of water (about 3 or 4 per cent.), it forms part of some particular kinds of sandstone. It is also found in natural hot springs, and even in common spring water,—no doubt by the action of carbonic acid. I have said that it is soluble in caustic alkali. It is soluble, for example, in caustic potash and caustic soda, not under ordinary temperature and pressure, but at a temperature of 300° or 400° F., and under steam pressure. Under these circumstances there is no difficulty in dissolving it. You get a solution in this way: a mixture of silica and potash combined with water, and a tenaceous though soluble fluid. I have a specimen of it before me. You see it is perfectly fluid; it is as much a fluid as water would be; but if in this state you expose it to the action of ordinary air for a time, it hardens, becoming first sticky and gelatinous. It is then a hydrate of silica. To become this it undergoes a certain kind of decomposition, parting with its potash to carbonic acid in the air. Before the lecture, I placed a drop of the fluid solution on a piece of glass, and those who take an interest in it may see what the effect has been. It was perfectly fluid; it is now quite gelatinous and sticky, and in a short time it will become perfectly hard. It has attached itself, also, firmly to the surface of the glass, and could not now be removed. In this form it was proposed to use the liquid silicate of potash, or water glass, by M. Kuhlman, whose process consists in the coating of absorbent stone with the solution in question, and he believed that after this treatment the stone would become coated with silica. Since it is known that silica laid on and dried is insoluble, he believed he had secured a useful result; but he forgot that insoluble silica that has been deposited in that way is still capable of being acted upon by the alkaline carbonates. Therefore, even when thus deposited, still in the course of time the alkaline carbonates of the atmosphere would act upon it, and it would be a failure. But that is not all; for, if at the time I put this drop on the glass I had not taken care that the glass was dry, or if I had dashed water on it, it would have been washed away. Now that is exactly what would happen if you put some of it on a stone, and a shower of rain were to fall. In that case the effect would be destroyed, the preparation being washed away. So much for the process which Kuhlman invented. It is right to say that M. Kuhlman himself believed that when used in limestone a double decomposition would take place, the silicate of potash being not only decomposed by the carbonic acid of the air, but a part of the silicic acid combining with the lime to form silicate of lime. This would, however, be a work of time, which the weather in a damp climate would not permit.

Another process has been introduced by Mr. Ransome. His plan was to decompose the silicate of potash and to produce a deposit of mineral upon it, which would adhere to the stone by a process of double decomposition. He considered that if a mineral deposit could be absorbed into the stone, I mean if, after a solution was absorbed into the

stone, it could afterwards, by a chemical combination caused by another solution subsequently absorbed, be decomposed so that a solid film would be everywhere deposited, and if this could be done in a very brief space of time, so that damp air, and rain should have no effect upon it, then the object required would be attained. It suggested itself to him in this way:—He was in the habit of manufacturing the soluble silicate on a large scale, and he thought that by combining it with the chloride of calcium (muriate of lime) he would get this double decomposition. This is the case, because soda and potash have but a weak affinity for silica, and lime a very strong one. Silica, therefore, parts very readily indeed with soda or potash to lime, whilst the chlorine would, with great readiness, pass to the soda. He therefore attempted the process; and I think you will say he attempted it with some success, at any rate so far as the experiment went. There is, however, no obscurity about the general result, as it is simply a matter of experiment. The first thing he did was to satisfy himself that he could get a rapid deposit. In the two glasses before me, one contains a certain proportion of silicate, and the other contains a corresponding proportion of the chloride of calcium, so that the two shall combine and form solids. In mixing these together, I put the chloride of calcium into the silicate of soda. The result is, that the affinity of the chlorine for sodium being greater than that for calcium, while the affinity of the silica for soda is weak, a double decomposition takes place, the chlorine leaving the calcium to pass to the sodium, thereby forming soluble chloride of sodium, or common salt, and the silica and lime set free, also combine to form silicate of lime, an insoluble salt, which is immediately thrown down in a solid state. The proportions being properly taken, the whole of the water is taken up and made use of as water of solidification, and the salt can be subsequently removed by washing.

[The lecturer, while performing the experiment, stated that by the time the lecture was over the whole of the contents of the glasses then liquid would be in a solid state, and added, that unless it was removed before long, the solid silicate of lime formed would adhere to the glass so firmly that it would be very difficult to get it off.]

We thus have silicate of lime rapidly formed, and being obtained in this way it is necessary to consider what the result would be in the solution of the problem before us. I need not say it is by no means sufficient to have an insoluble mineral deposit placed on the surface of a mineral whether calcareous or silicious. It is not only necessary to have that, since there must also be cohesion, and this cohesion must be sufficiently powerful to render the mineral coating preservative. It is absolutely necessary that the silicate of lime should be a material which, when put on a surface of stone, should not only remain there, but become permanently adherent. Experience, however, has long ago shown that a very thin deposit of this peculiar mineral, silicate of lime, does adhere with singular rapidity, and with the most remarkable tenacity, to particles of sand and stone with which it comes in contact. It is the film which, produced gradually, gives all its value to mortar, and which cements together the stones of which are formed what build-

we call concrete, on the very existence of which as a firm solid mass, half our buildings depend. Immediately on the deposit of the minute particles produced by the double decomposition of two minerals and formation of two others, this strong tendency to adhere comes into operation. The particles of silicate of lime newly set free, immediately and firmly attach themselves to the particles or grains of which the stone is made up, not only surrounding them, but binding them to each other, just as when mortar has long been left to harden it is as difficult to separate the parts cemented as it is the solid brick or stone; this it is which gives its principle value to the method suggested.

I have laid on the table several specimens of different materials which have been treated in this way, and also some of the results after they have been exposed to decomposing agencies. Near me are two specimens of terra cotta. One has not been treated in any way, and it is exceedingly absorbent, and we know from experience that terra cotta soon becomes injured on exposure to the weather. The other has been treated by the processes that I have mentioned, and if any one will take the trouble to scratch the surface, he will at once see the nature of the change. The surface has become excessively hard, and although when treated this way it is not necessarily non-absorbent, it can be made so by repeating the process often enough. If not made non-absorbent, however, it has become less capable of injury by exposure. These specimens were prepared at the Museum at South Kensington.

There is also before me a specimen of Heddington stone exposed to Ransome's process, and another specimen of the same stone not exposed to that process. Both of them have been dipped in acid, and the result is as you see. The surface of one is entirely gone; the surface of the other is not touched. There are also two specimens of Caen stone, one exposed to the process and the other not. Both have been subjected to the same amount of acid, and the result is that one stone is entirely destroyed and the other is not injured. There are several other specimens of Mr. Ransome's stones on the table, and the hardness of them will be at once recognised by any one who will compare them with similar stones not so treated.

There is another process which I ought to mention, which has been partly carried into operation in the Houses of Parliament. It was introduced by a Hungarian gentleman, of the name of Szerelmey.* I

* Since the lecture was delivered a correspondence has been printed by order of the House of Commons which renders some further observations desirable:—Mr. Szerelmey had not, I now find, allowed me to ascertain the real nature of the method he adopted, which consists in the use of soluble alkaline silicates, succeeded by a wash of bituminous matter also in solution. This was stated in confidence to Dr. Faraday, who, however, does not say that the application of the soluble silicates is succeeded by a second wash producing a deposit of silicate of lime. We are led to infer that the second wash is the bitumen only, and the object of this must be to shelter the surface while the alkaline silicate is undergoing slow decomposition and becoming converted either into hydrate of silica or silicate of lime, just as by Kuhlman's method. It would thus appear to be Kuhlman's process with the addition of a bituminous and temporary sheltering surface. It still remains to determine whether by this process permanent protection is given, as if the deposit consists of hydrate of silica, the alkaline carbonates to which it must soon be exposed will no doubt destroy it. The temporary shelter of bitumen cannot be taken into account as having permanent value, although, for the time it lasts, it may, no doubt, appear to be more efficacious than any thing else. I observe that Dr. Faraday, in expressing a qualified opinion on the present appearance of the stone thus acted on, speaks "of the short and insufficient evidence now existing." It is indeed clear that the real value of the method of Kuhlman depends on the nature of the deposit formed, and I believe it has not yet been determined what this is, simply because there has not been time enough given for the experiment. Complete exposure of a surface protected by Mr. Szerelmey left without any subsequent treatment for some years (four at least), could alone decide the question. The condition of the Speaker's Court, in the Houses of Parliament, will thus after a time be a fair test of the value of his method.—D. T. Ansted.—26th May, 1860.

can hardly with propriety say any thing about it. I know too much and too little about it to be able to express an opinion. At the same time, if I did not mention it, it might seem as if I had not been aware of it. Mr. Szerelmey, at the suggestion, I believe, of the late Sir Charles Barry, asked me to look at his process, but he did not inform me what its preservative power consisted of, and although he intimated its nature, he evidently intended me to regard what I observed as confidential. All I can say is, that regarding it as a secret process, it is quite impossible for any one to express an unqualified opinion of its value until time shall have tested its capabilities. It is, therefore, best not to speak of it at all until it has been exposed for a number of years to the action of the weather. Time alone can show what its value is, if the materials employed are not stated, and certainly an experience of not less than several years can be regarded as of any value, since ordinary paint or drying oil will preserve absorbent stones for that period.

In returning now to the original subject, let me remind you that if, as seems to be the case, we are forced to make use of soft, perishable material for purposes of decorative work in architecture, if we are obliged to accept the material that nature has provided near at hand, and select from varieties which differ indeed much in durability but all of which decay, it would seem only reasonable that due precaution should be observed to take for the best work the most favorable varieties of stone, and use great caution in rejecting manifestly bad or indifferently good samples. That this can be done every quarry-man and every stone-mason well knows, and there are means of determining the good from the bad which are independent of their experience. Where enormous sums are to be expended on decorations for a permanent building, it is surely not unreasonable to expect and require that a little niggardly economy in regard to the material of construction should not be indulged in. But I regret to say that in most modern public buildings it has not been thought necessary either to determine the kind of stone with reference to its probable durability, or to appoint a competent person to reject on the spot bad samples. With regard to our architects, it seems hardly to be a part of their education to inquire into and understand such matters, and they do not consider themselves responsible ultimately for the consequences of neglect. I have endeavored to show what must happen when bad stones are placed in a building erected in or very near a large town. The whole of the stone decays, but the more prominent and the more ornamental parts, those on which the effect most depends, and on which most money has been spent, these decay first. Moisture is absorbed, frost comes, and the delicate projecting parts fall. Gases and acids are absorbed together with smoke, and the stone is first blackened and disintegrated, and then reduced to powder. But of course there are bad and good pieces; there are exposed places and sheltered places, and the result of this is that not only does the stone decay, but it decays with the utmost irregularity: adjacent stones become very soon in a state so different that no one could have supposed they were dug from the same quarry, and the whole surface is unsightly and disfigured.

None of the nobleness and beauty of decay is seen in these cases. There is a decent and picturesque appearance, not unfrequently met with, in old buildings which inspires respect instead of dislike. There is the hoary front of age, of which none can complain. It is seen in the marbles of Greece and Asia Minor, in the limestones of Rome, and even in some of the porphyries in Egypt. Time, we are told, devours all things. All human contrivances must submit to it, and as it is a natural, so it is often a beautiful condition. But premature decay, like an artificial ruin, has a poor and mean appearance. It does not give the idea of waning strength, but of absolute innate weakness. It is a *coup manqué*—a thing not merely imperfect, but unnecessarily imperfect.

It is important to remark also that bad stone was not always used. Many of our old buildings have scarcely shown incipient decay—many of those in large towns have decayed so as not to be unsightly. This, it is true, must not be altogether attributed to the material, as such buildings, if erected now with picked stone from the same quarries, would probably injure much sooner, owing to the much larger quantity of impurity in the atmosphere to which they are exposed. When a stone has been for some time exposed to pure air it hardens, and thus buildings, placed where we see them before the large town arose around them, have stood exposure better than they could do now. But there is reason to know that the selection of stone was much more careful formerly than it has been lately, and the result is manifest.

There is one more point. If the method of protection and preservation so ingeniously contrived by Mr. Ransome is successful, as it really seems to be, the softer and cheaper stones may be used. It is certainly the case that a hard, almost flinty surface is obtained by it, and that such surface is not acted upon by the acids which rapidly destroy the same stone when unprotected. For four winters stones thus protected have stood the action of the weather, and if it turn out to be as durable as seems likely, from this and other trials on a large scale, if absorption is checked—so far at least as its injurious effects are concerned—for mere absorption does not seem to be injurious, and if decay is thus arrested, then there are means at hand which cannot fail to have a great influence on decorative stone-work, for the material most easily carved and sculptured is just that one which is most completely improved by the process.

In thus speaking of the decay and preservation of stone, I have endeavored to confine myself strictly to the subject before me, not traveling out of the record. I feel, however, so convinced of its importance that I offer no apology for bringing it before you, and, perhaps, when in your summer ramblings you visit some noble cathedral, or wander over the ruins of some ancient castle or tower of classical or middle age construction, you may feel an interest in examining the cause of the beauty you there see arising from decay, and contrast it with the dissatisfaction and disappointment I am sure you cannot help feeling on examining some of the recent restorations of Westminster Abbey, or the richly decorated surface of the great palace of the nation immediately adjacent.

*Abstract of a Paper on Steam Boilers.** By F. H. Sawyer.

The author, after pointing out the main features of the different varieties of steam boilers, proceeded to a more minute consideration of the marine, as being, in his opinion, the most important. In describing the flue boiler, he remarked that it was quite impossible to give a very accurate account of the proportions of heating surface to fire-grate, &c., as one pair of engines might exert only their nominal horse power, whilst another pair might exert four or five times as much. The author argued the great superiority of the multitubular, as compared with flue boilers, founding his preference on the fact that a boiler of the former kind might be applied with a reduction of sometimes one-third the space, and even a greater proportion of weight, and at the same time giving a greater heating surface per horse power. In exemplification of this he gave the particulars of the original flue boilers of the *Great Western* steam ship, and compared them with the new boilers of the tubular principle, afterwards substituted; the results being as follows:

	Old Boiler.	New Boiler.
Weight with water,	280 tons.	108 tons.
Heating surface per H.P.,	9·6 sq. feet.	17·8 sq. feet.
Area of fire-grate, per H.P.,	.5 "	·36 "
Consumption of coal, per H.P. per hour,	8·33 lbs.	5·6 lbs.

The author was of opinion that, by the application of a blast in the funnel, a greater quantity of fuel might be burnt per square foot of fire-bar, and that, therefore, a boiler of smaller dimensions would be attainable; remarking, at the same time, that he considered that, in some cases, the space thus saved would counterbalance the space and value of the extra fuel used. The author then proceeded to discuss the adoption of a higher pressure of steam, together with the principle of surface condensation, noticing that we could not hope for a successful result by jumping at once from 20 lbs. to 50 lbs. per square inch, but he had no doubt that the advantages of a higher pressure would be seen, and that we should see it gradually increasing in the same manner as it had increased from 4 lbs. to 20 lbs., showing a corresponding reduction in the consumption of fuel. He did not expect to see the economy reduced so low as was said to be the case in the *Thetis;* and although he had no doubt but that considerable economy had been attained in that vessel, at the same time he was not prepared to admit or credit the very wonderful economy said to have been realized.

After giving the dimensions and particulars of the tubular boilers of the *Queen* steamer, constructed by Messrs. Rennie, and noticing them as an advantageous description of boiler, the author proceeded to discuss the advisability of brick or iron fire bridges, giving his decided preference to the brick, from the ease with which they can be altered or removed, and also from the fact that the iron bridges so soon wear out, owing to the difficulty the steam has in escaping from the interior, and their great liability to corrosion from the water that might escape from the tubes.

*From the Lond. Engineer, No. 220.

In a boiler of good proportions he considered there should be no priming, but should any take place owing to dirtiness of water, passing from fresh water in salt, or *vice versa*, he recommended the use of tallow, or as a preferable expedient, if circumstances permitted, opening the fire-doors and slackening the fires. He considered, also, that some trouble might be caused by priming in small high-pressure marine boilers, unless great care was exercised.

The author devoted but a small portion of his paper to the consideration of the stationary and locomotive boilers, but occupied some of his remaining time in discussing the relative economy of the Cornish and locomotive boilers, considering the Cornish greatly superior, as in a locomotive the temperature in the smoke-box was notoriously greater than the temperature at the base of the chimney in a Cornish boiler, and that the heat passed up the funnel was a dead loss, except that which was necessary to keep up the draft.

The author concluded by giving the dimensions and mode of construction of one of Stephenson's 12 in. locomotive engines, as also that of Crampton's colossal engine, the Liverpool.—*Proc. Civ. and Mech. Eng. Soc.*

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*The Decay of Timber and its Prevention.** By H. LETHEBY, M.B., M.A., &c., Professor of Chemistry in the College of the London Hospital.

SIR:—I regret that I was not able to be present at the Society of Arts, on the 30th May, during the reading of Mr. Burnell's very valuable paper on the causes of decay in building woods, and the means of preventing it; for, as I have directed much attention to the subject, and especially to the *modus operandi* of creosote, or dead oil, in preserving timber, I should have taken part in the discussion.

Mr. Burnell does not attach too much importance to the process of creosoting timber, when he regards it as the most effective of all the processes known for the prevention of decay; for, in truth, the dead oil of common coal-tar contains all the elements which are necessary for giving permanent stability to organic compounds, by checking decomposition, by opposing the processes of oxidation, and by destroying the vitality of the lower forms of animal and vegetable life. If, indeed, the application of creosote to timber has ever failed in preventing decay, it has been because of the improper use of it, or the use of an oil which has not contained a due proportion of its most effective constituent—carbolic acid. This it is which is chiefly concerned in strengthening the weak affinities of the young or immature constituents of wood. It coagulates the albumen and gives firmness to the cellulose matters that are so prone to decay, and which communicate by a sort of catalytic influence, their decomposition to the neighboring and more mature tissues. So powerful is the antiseptic property of this acid that, when separated from coal tar, it will at once arrest the decomposition of every kind of organic matter. I have seen it stop the putrefactive changes of sewage and cess-pool matter instantly, and it will even stay

* From the Journal of the Society of Arts, No. 395.

the more active decomposition of putrefying animal flesh. It is to be regretted that all samples of dead oil do not contain a like proportion of this valuable constituent. I have found that it ranges from 0·05 per cent. to rather more than 6 per cent. of the oil; and as the value of the oil is dependent on the proportion of this acid, it is a matter of some importance to know how its presence can be discovered. A rough estimate may easily be made by shaking up about half a pint of dead oil with its own bulk of a rather weak solution of caustic potash. After standing for a little while, the oil will separate, and the potash solution of the carbolic acid may be poured off. On acidulating this with sulphuric acid, the carbolic acid will separate, like an oil, and it may be known by its creosote-like odor.

Another important constituent of dead oil is the hydro-carbon, which gradually discolors the oil and thickens it by absorbing atmospheric oxygen and forming a solid pitch. This operates in preserving wood by appropriating the oxygen which may be within its pores, and so checking ligneous eremacausis. The resinoid body which is formed shuts up the pores of the wood and effectually protects it from the action of air and moisture. The presence of this hydro-carbon may be known by the darkening, and, as it were, drying of the oil when it is put upon white filter paper and exposed to the air. In the distillation of the oil this compound comes over most freely at the time when naphthaline distils; and as far as my experiments have gone, I am led to think that the best dead oil (that charged with most carbolic acid, and the resinafiable hydro-carbon) comes over at from 360° to 490° Fahr. The carbolic acid is most abundant in the runnings at or near to the first temperature, and the media for holding them in solution and applying them to the timber at the last. Naphthaline, and paranaphthaline, or salts, as they are sometimes termed, will of course come over at these temperatures; but as these substances are of no value whatever in preserving timber, they should be separated as far as possible by submitting the oil to cold and to the action of time. Dead oil should not be exposed to the air more than is necessary, in order that oxygen may not be absorbed and the oil thickened and discolored. Lastly, I may say that carbolic acid and the hydro-carbons of dead oil are among the most powerful poisons to fungi, and acori, and all the lower forms of organic life. The oil, therefore, acts as a physiological preservative of timber. In point of fact its preservative action is of four kinds:

1. It coagulates albuminous substances, and gives stability to the constituents of the cambium and cellulose of the young wood.

2. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissue.

3. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.

4. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acori, and other parasites.

No doubt the action of the oil is injurious to higher forms of animal life. It is even offensive to ourselves, and hence the objection to its use in the interior of buildings. But I am led to think that this objection may be overcome by the use of agents, which, like nitric acid in its action on the benzole of the lighter oil of coal tar, may give to the dead oil a less offensive, if not a positively pleasant odor. When this is accomplished there can be no objection to its use in the interior of buildings, or for the preservation of ships.

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*Description of a Steam Crane.** By Mr. J. Campbell Evans, of Greenwich.

The steam crane described in the present paper was designed more especially for use on board steam vessels; and the chief points to be aimed at were consequently compactness, facility of fixing, simplicity in the mode of working, and durability. In cranes usually constructed, the boiler being separate from the engine, the union joints of the steam pipe are very liable to leak; and the writer believes there are very few such cranes where this circumstance has not been a continual source of trouble and annoyance after a few months' regular work. Frequently the boiler is a considerable distance away from the cylinder, and then the steam and feed pipes are liable to be injured in stowing the cargo; in addition to which, the condensed steam strains the machinery, and keeps the deck of the vessel constantly wet and dirty.

To obviate these disadvantages, in the present steam crane, the boiler is placed as close as possible to the crane, and revolves with it; and by making the top of the boiler of cast iron, with lugs for attaching the tension rods, it serves the double purpose of boiler and crane post. The bed-plate upon which the crane and boiler are placed is fixed to the foundation-plate by a centre bolt, which bears all the upward strain; the downward pressure is taken by rollers, having their bearings in the bed-plate, and running on the foundation-plate, which is solidly bedded on timber laid on the deck of the vessel.

To avoid upright tubes and horizontal tube plates, the heating surface of the boiler is arranged in cones; the first cone or fire-box is exposed to the direct radiation of the fire, after which the heat passes through an opening nearly opposite the fire door into an annular space between the second and third cones, where it is absorbed by the water spaces on either side, and passes round to the funnel opposite. In this way a sufficient heating surface is obtained without any horizontal surfaces in the boiler for deposit to accumulate upon. The two angles or bottoms of the water spaces are below the direct action of the fire, and are connected by pipes to allow for the circulation of the water, provided with plugs and cocks for cleaning. The water tank is placed under the boiler; this position serving to heat the feed water and to preserve the cast iron bed-plate from danger of fracture by the heat of the fire.

The crane is worked by a single oscillating cylinder, supported by

* From Newton's London Journal, August, 1860.

brackets on the bed-plate. The joints for the steam and exhaust pipes at the trunnions are made tight by gun-metal cones, fitted to the trunnions and held by studs in the brackets; when these have become polished by working, the wear upon them is very slight, and this construction has been found very suitable for the rough treatment to which cranes are usually subject. On the crank shaft is a friction wheel, grooved according to Mr. Robertson's plan, and kept continually revolving by the engine. On the second shaft is another friction wheel, which, by means of a lever, can be moved into gear with the driving wheel, or, by an opposite motion of the lever, can be pressed against a brake, or when lowering can be held between the two. The other end of the second shaft carries pinions gearing into wheels on the shaft of the chain barrel. There are two pairs of wheels and pinions, for varying the speed according to the weight to be raised; the pinions are thrown in and out of gear by a sliding key, instead of the ordinary clutch; by which means, the width between the frames that would be required for moving the ordinary clutch is saved.

The writer believes the principal difficulty experienced in steam cranes for ship purposes is in the arrangement of the turning gear; so that when the vessel leans over to one side, the crane shall be powerful enough to swing the weight, and yet not cause a sudden start or shock to break the gear. In this crane, a coned friction clutch is used, to allow a slip at first and to start the weight gradually; and the arrangement of the foundation-plate of the crane admits of a much larger spur-wheel than usual being employed to bring up the power. On the crank shaft is a worm working into a worm wheel, on the shaft of which is a bevil wheel, gearing into the two bevil wheels above and below, which are thus kept constantly revolving by the engine. By means of a coned clutch acting on one or other of these wheels, the crane can be moved round either way, as desired. The two operations of lifting and turning the weight are easily managed by one man.

The valve motion of the oscillating cylinder is designed to compensate for the oscillation of the cylinder without the use of sweeps and guides. A radius rod is centred on the cylinder bracket, and connected to the eccentric rod by a link, to which the valve rod is attached by a pin. The link combines the vibrations of the eccentric rod and radius rod, so that at the point where the valve rod is attached, the curve described by the radius rod compensates for that described by the eccentric rod in such a degree as to bring the valve rod into the curve it would naturally be made to describe by the oscillation of the cylinder.

Mr. Evans observed that the crane was intended as a machine of simple construction, complete in itself, including boiler, for fixing in such situations as on decks of vessels or on quays, where generally the expense of larger stationary boilers for working a number of separate steam cranes could not be gone to. These cranes had worked very satisfactorily, the only wear, after more than a year's work, being in the bearing of the crank shaft, and by tightening up the nuts of the cap one-eighth of a turn, all the wear of some months was taken up.

There was an advantage in the leverage in turning round, and the crane was found very convenient for handling; the grooved friction wheels, for connecting and disconnecting the motions, had proved very satisfactory, and worked smoothly and efficiently.

Mr. H. Maudslay inquired what pressure of steam was used, and what weight could be easily lifted by the crane; and what was the cost of the whole.

Mr. Evans replied, that 30 to 40 lbs. steam was used, and the crane lifted 50 cwts.; a larger size was being constructed to lift 50 cwts. 42 feet high in half a minute. The cost of the cranes at present made was about £200 complete; no pipes were required for connexion to the boiler as in detached steam cranes, and no fixings were wanted for the crane or boiler; all that was required was to lay down 4-inch timbers to bed the frame upon, and it was a particular advantage in the case of ships that no holes were required in the deck for the crane post, the whole being self-contained.

Mr. E. A. Cowper thought it was a disadvantage in the arrangement that the steam must be shut off directly the load was off to prevent the engine running away; and a single cylinder had this disadvantage—that it might stop on the centre, causing a delay in starting the crane again. He thought it was preferable, for working a crane, to have two cylinders working cranks at right angles and with link motion, as in Taylor's steam winch; the engines were then started or reversed readily, in whatever position they might have been stopped, and there was a decided advantage in thus getting rid of the fly-wheel.

Mr. Evans replied, this difficulty of a single cylinder was completely met in the present crane by having a small hole remaining open when the steam was shut off, which allowed steam still to pass just sufficient to keep the engine constantly moving at a slow speed, and turning only the first of the friction wheels. A double-cylinder crane would involve greater cost and complication, and a good deal of knocking was liable to occur in the gearing of a quick working crane on that plan; there was also the objection of water accumulating in the cylinders when standing, which was avoided by having the engine always moving.

Mr. H. Maudslay thought it a good idea to put the boiler at the back end to balance the jib, which made an advantageous arrangement. In a 30-ton steam crane recently erected in the wharf at Messrs. Maudslay, Son & Field's works, the engine was fixed upon the jib, consisting of a pair of small cylinders, with short stroke, working cranks at right angles; the crane lifted 30 tons and the lowering and raising were done very smoothly by the cylinders; for lowering such a weight double cylinders were of course wanted, to prevent a jerk.—*Proc. Inst. Mech. Engineers.*

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*On Road Locomotives.** By the Earl of Caithness.

My present object is not to enter into any detailed history of the steam engine from its commencement, or to trace its gradual improve-

* From the London Civ. Eng. and Arch. Jour., August, 1860.

ment, but to place before you as briefly as possible some of the advantages that may accrue from it as a means of transit on our common roads.

The public mind is usually set against any thing new. When steamers were first spoken of they were looked on as a most wild and dangerous expedient. They would be constantly on fire,—would not, or could not go to sea,—and if they did, who would be found mad enough to go with them? Mr. Miller, of Dalswinton, found this to the cost of mind and person; and Mr. Bell, though more successful with his first boat on the Clyde, had his battle to fight against public opinion. Railways at first were looked on as wild and visionary, and dangerous in the extreme to Her Majesty's subjects. Thanks to George Stephenson, his perseverance had its reward, not only to himself, but in a much larger degree to us.

My object is to lay before you what in my opinion may some day work nearly as great a benefit on society as our railways. The subject is not new, but I am not aware that it has ever been brought before the British Association. It is road locomotion by steam. It seems the more important at this time to discuss the subject, as at present a bill is before parliament to enact certain tolls on locomotives; and so much fear is expressed by various parties as to the freedom from danger of these machines, that I think it a favorable opportunity to bring the subject before the meeting. Various plans have been tried, and vast sums of money expended, in endeavoring to perfect a good road locomotive. Watt designed one to carry two persons, but it was not constructed, his other employment taking up so much time as to prevent him carrying it out. The first actual steam carriage we read of was made by a Frenchman named Cugnot, who showed it to Marshal Saxe in 1763. He afterwards made one that, when first set in motion, went through a wall, and being by this means or other violent exhibition of its powers considered very dangerous, was placed in the Arsenal Museum at Paris, where it now is. An American, Oliver Evans, also invented a steam carriage in 1772, but it did not come into use. William Symington conceived the same idea for Scotland, but the roads were then so bad, that, to speak in a slang way, it was "no go;" this was in 1786. The next inventor was William Murdoch, who in 1784 made a model of a steam carriage, which is still in possession of a relative of Murdoch's. Another inventor of steam carriages was Thomas Allen, of London, who in 1789 designed one to carry goods and passengers.

The most successful, however, seems to have been a locomotive built by Richard Trevethick, of Cornwall, and Andrew Vivian, his cousin, (Trevethick was a pupil of William Murdoch.) He took out a patent for it in 1802. His carriage was like a common stage-coach. It had only one cylinder. This was the first successful engine made to work with high-pressure, moving the piston both ways against the pressure of the atmosphere only. The first road steam-carriage was, on the whole, wonderfully successful. It caused great excitement in his neighborhood. This carriage safely reached London, and was publicly exhibited on an inclosed piece of ground where Euston-station now stands.

Having thus shown that in the early days of steam, carriages were made and driven on common roads, I am about to bring the subject before this meeting, in the hope if it is now taken up, and backed by the British Association, we shall have this most useful, and now well understood power, brought to bear as a most efficient means of conveying heavy goods and passengers, as tenders to our railways, instead of making so many short branches of railways that do not pay.

Mr. Scott Russell, many years ago, made a successful steam carriage that ran between Glasgow and Paisley; and if it had not been for a most unfortunate misunderstanding between the promoters of the carriage and the road trustees, whereby a fatal accident took place, I believe it would then have made a great stride in the right direction. It performed its journey very well for some time.

One of the great reasons why we may now look for success in road locomotives is, that instead of as formerly having a heavy machine or carriage worked with a comparatively light pressure of steam, we now have a light carriage and worked at a heavy pressure. We now have the means of making very strong boilers very light, and to stand a high pressure.

A number of plans have been tried, all more or less successful. The first one that came out of late was Mr. Boydell's, with its endless railway attached to its wheels. This carriage, though I have not seen it at work, has, I understand, drawn great weights after it at a cost much less than that of horse-power; and though clumsy in appearance, yet that may be got over. The first thing in my mind is to establish the actual working of this mode of hauling.

We have now another and also a most successful steam carriage in Mr. Bray's. It is very ingenious. It has now been working for some time with perfect success; and though it was unfortunately transmogrified last year into a green dragon, and for a time gave in, yet there is no reason why it should not turn out a most useful machine. Indeed it has proved itself so a great many times within a few months, in taking large loads through London. It has drawn over thirty tons through the most crowded thoroughfares of London, and in no instance has any accident occurred during its employment. The economy in its use has been equal to a saving of one-half the cost of employing horse-power.

Mr. McConnell, to whom the world is largely indebted for very valuable improvements in the locomotive engine, has, I believe, undertaken to give his able attention to this subject, with a view to bring out a simpler engine than that now in use. This I feel can be done with ease, so as to make a much more workable and less costly machine. I think great speed should not be looked for in traction engines. What is wanted, in my opinion, is a means of taking large loads at a small cost. It is a great mistake to suppose that injury is done to the road by the use of steam carriages. The truth is that there is much less injury done than by using horses,—the broad wheels acting like rollers, and so rather improving than hurting the road.

The Marquis of Stafford has had a small steam carriage in use now for two years, and it works with great ease. It was made by Mr. Rickett, of Castle Foundry, Buckingham. Since it was made Mr.

Rickett has made two others, introducing great improvements, being direct acting instead of being driven by a pitch chain. One of these carriages has been built for myself. It weighs one ton and a half, and I have had a speed of nearly twenty miles an hour out of it. I gave a suggestion as to the mode of placing the axle in connexion with the driving gear, which I will explain. I placed the axle of the road wheel in radial segments, so that the springs rise and fall by the action of the road, the driving gear or toothed wheels are never allowed to be at a greater distance from each other at any time; the axle as it rises or falls performing a part of a revolution round a crank shaft, on which is fixed the smaller wheel which gives the action to the road wheels. Its action is perfect, as the teeth of the wheels are always in gear to the same depth; and the consequence is that the springs act most perfectly, and it goes along the road without trouble. I have now had several trips on it from Buckingham to Wolverton, a distance of ten miles, and this has been done within the hour including stoppages.

Another advantage of steam on roads over horse-power is, that instead of requiring twenty or thirty horses, forming quite a troop, to take a carriage containing some heavy weight, you place before the said carriage a steam engine. This power will cost but a small sum in comparison with horses; it will be a constant power so long as it gets coal and water. It will take up but little room, not being much larger than a common carriage. This seems a most important reason for the advancement of steam, as at this present day saving of time, money, space, and at the same time gaining increase of power, are cogent reasons for advocating any cause.—*Proc. Brit. Assoc.*, 1860.

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*Horse Railways on Common Roads.** By John Crane.

To the Editors of the Mechanics' Magazine:—

Gentlemen:—Perfectly agreeing with yourselves and Messrs. Train & Burn in the advantages to be derived from horse railways, I humbly crave a corner in your able and liberal Magazine for a brief exposition of my own views on a mere matter of debateable detail. It strikes me that there is no need whatever for the vehicles that run on rails in public streets to have flanched wheels, which would prevent their running except on such rails; but that the present wheels might be retained, provided all the axletrees were made the same length, and a form of rail adopted like that in Fig. 1. It may be called a "trough rail," and is five inches wide inside, with two flanches, and to be fixed on continuous longitudinal wooden sleepers, or embedded in stone blocks laid down at intervals of about four feet. I also recommend a stone curb to be laid along each side of the rail, such as is now generally used for curbing

Fig. 1.

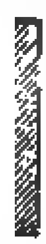
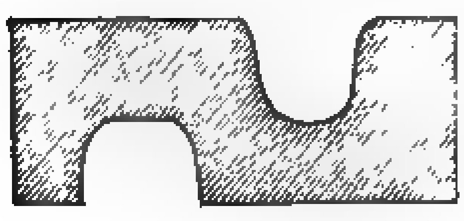


Fig. 2.



*From the Lond. Mechanics' Magazine, June, 1860.

foot-paths. But if a flanched wheel be preferred, then I think the form of the rail in Fig. 2 is better suited to meet the various requirements of the case than any I have yet seen. Each could be made either of wrought or cast iron, and of course of any dimensions to suit the particular traffic. I will not now take up any more of your space or your readers' time by enlarging on the advantage of my proposed plans, but conclude by assuring you that—whether they are novel or not—I shall not patent them, but present them to the public gratuitously.

59 Lee Crescent, Birmingham, May 31, 1860.

For the Journal of the Franklin Institute.

New Rule for Depths of Keystone for either Segmental or Elliptic Arches of Stone. By John C. Trautwine, C.E., Philada.

I submit the following original rule for determining the depth of keystone for either segmental or elliptic arches of stone, as coinciding more nearly than any other with which I am acquainted, with the practice of the best engineers:

For first class cut-stone work of hard material take ·36 of the square root of the radius at the crown. For second class work ·4; and for brick or rubble arches ·45 of the same square root.

The following examples will show the accordance of the rule with existing structures both elliptic and segmental, in the first case, viz: with first class work and materials.

$$\cdot 36\sqrt{\text{Radius at crown.}}$$

	Span in feet.	Rise in feet.	Rad. at Crown in feet.	Actual Key in feet.	Calcul'd Key in feet.	Engineer.
Cabin John Aqueduct and Roadway Arch of the Washington Aqueduct,*	220	57¼	134¼	4·16	4·17	Meigs.
Grosvenor Bridge, across the Dee,	200	42	140	4·00	4·26	Harrison.
London Bridge (new), Thames,	152	29½	162	4·75	4·58	Rennie.
Gloucester Bridge, Severn,	150	35	150	4·50	4·41	Telford.
Claix Bridge, France,	150	54	82	3·10	3·26	
Dora, Turin,	148	18	160	4·80	4·55	Mosca.
Neuilly, as designed,	128	32	160	5·30	4·55	Perronet.
Neuilly, as it exists on account of the settlement of the arches,	128		250	5·30	5·69	Perronet.
Licking Aqueduct, Ches. and Ohio Canal,	90	15	76	2·83	3·14	Fisk.
Staines Bridge,	74	9·3	78 —	3·00—	3·18	Rennie.
Bow Bridge, England,	66	13·75	81	2·50	3·24	Walker and Burges.
Monocacy Aqueduct,	54	9	50·0	2·50	2·55	Fisk.
Lugar Viaduct, Scotland,	50	25·00	25·0	2·00	1·80	Miller.
James River Aqueduct,	50	7	47·0	2·66	2·47	Ellet.
Reading Railroad, at Reading,	31	5	26·8	1·66	1·86	Steele.
Semi-circle,	2·0	1·00	1·0		0·33	
Pont Napoleon Viaduct, Paris, small rubble masonry in cement; multiply by ·45,	115·5	14·75	120	4·00	4·93	Couche.
Maidenhead Viaduct, brick in cement; multiply by ·45	128	24·25	169·0	5·25	5·85	Brunel.

Our public works abound with cut-stone arches having keys varying from ·36 to ·4 of the square root of the radius of the crown, and with rubble arches having keys from ·4 to ·45 of the same square root; but I have not thought it necessary to introduce them.

*This is the largest stone arch of modern times, or, *perhaps*, of any former period, unless we except the ancient bridge of Trezzo, *said to have been* 251 feet span; it was designed, and its erection superintended by Capt. Montgomery C. Meigs, of the U. S. Topog. Engineers.

MECHANICS, PHYSICS, AND CHEMISTRY.

*Hicks' Maximum and Minimum Mercurial Thermometer.**

The following description of a new maximum and minimum mercurial thermometer invented by Mr. James Hicks, was written by Balfour Stewart, Esq., and communicated to the Royal Society by J. P. Gassiot, Esq.:—

About a fortnight since, Mr. James Hicks, the intelligent foreman of Mr. L. P. Casella, optician, called at Kew Observatory with an instrument of the accompanying description, for the purpose of having it compared with the ordinary maximum and minimum thermometers. This comparison proving very satisfactory, and the principle of the instrument commending itself to Dr. Robinson, Mr. Gassiot, Professor Walker, and several other scientific men who examined it, Mr. Gassiot requested me to write a short description of it, which he thought might be of interest to the Royal Society. For many particulars of this description I am indebted to Mr. Casella, and Mr. Hicks, who furnished me with details regarding the construction of the instrument.

Its chief advantage consists in its furnishing us with a mercurial minimum thermometer, no serviceable instrument of this description having hitherto been made. At the same time it is also capable of being used as a mercurial maximum thermometer.

The principle of the instrument is briefly as follows:—It has a cylindrical bulb nearly three and a half inches long and half an inch in diameter, filled with mercury. This gives a bore nearly $\frac{1}{20}$th of an inch wide, and a scale on which 1° Fahrenheit corresponds to about $\frac{1}{25}$th of an inch, when the graduation has reached 150° F. or so; both the tube and the scale are made to assume a position at right angles to that which usly, so that the first portion of the ertical, the second will be horizontal. horizontal scale are not, however, in on the vertical, for in the instrument unt is taken, while 150° is the highest al scale, the first on the horizontal is ɔe third 10°, and so on. The reason of ιtion will immediately appear. Above a small quantity of spirits of wine, listance into the horizontal tube. The he graduation, correspond in such manend of the spirit column denotes the erature as the mercury. The remainder of the horizontal tube is filled with air. There are two movable indices in the spirit column, one in the vertical tube, the other in the horizontal, each about half an inch long. The former, B, consists of

* From the Mechanics' Magazine, June, 1860.

a fine steel magnet inclosed in glass. This forms the body of the index. At either extremity there is a head of black glass, similar to that which occurs in the index of an ordinary minimum themometer. A fine hair is tied round the neck of this index, between the body and the upper head; and it is made to hang down by the side so that by its elastic pressure against the tube the index may be kept in its place notwithstanding its verticality. The index in the horizontal tube A is in all respects similar to that of an ordinary maximum thermometer.

Let us now suppose the instrument fixed in its position, the first part of the stem being vertical. In order to adjust it we must first bring the vertical index into contact with the upper extremity of the mercurial column. To do this, let us take two small but strong horseshoe magnets, and lay the one above the other, so that the poles of the one shall overlap to a small extent the corresponding poles of the other. Bring the magnets up to the index in such a manner that, while the poles of the one bear against the side of the glass tube, the overlapping poles shall lie over the tube so as to be in front of the index; the index will now follow the motion of the magnets, and it may thus be brought down to the surface of the mercury. In order to bring the horizontal index to the extremity of the spirit column, all that is necessary is to incline the horizontal tube a little downwards by pressing on the end. The indices being now set and the instrument in adjustment, let us suppose the temperature to rise—the mercurial column will push the vertical index up, but this index will remain in its place when the mercury again falls, and will, therefore, denote the maximum temperature reached. On the other hand, let us suppose the temperature to fall—the mercury in falling is followed by the spirit column propelled by the air behind it. The spirit column again will, on its edge coming in contact with the end of the horizontal index, draw the index with it into a position, where it will remain when the mercury again rises. This index will, therefore, register the extreme minimum point which the spirit column has reached; but by the principle of graduation this will correspond with the minimum point reached by the mercurial column.

Let us now suppose that a small portion of the spirit column has become separated, and lodged itself in the extremity of the tube. The principle of graduation will immediately enable us to discover this by a want of correspondence being produced in the reading of the mercurial and of the spirit columns. If, for instance, before the separation the mercury read 50°, and the horizontal extremity of the spirit column also 50°, it is clear that, after the abstraction of spirits has taken place, the horizontal column will read lower. We have thus a check upon this possible source of error, which we have not in the ordinary minimum thermometer. Indeed, it is to all intents a mercurial minimum thermometer that we are now describing, the spirits serving merely as a vehicle for the indices. It will be remarked that were both columns capable of acting in a horizontal position, there would be no necessity for the bend, and the instrument would be more portable; but in this position it is found there is danger of the spirits becoming

mixed with the mercury, and thus interfering with the action of the instrument. Should this ever be brought about by traveling, or any cause, a smart jerk or two of the instrument will join the separated columns and put all right.

The instrument is thus constructed:—The vertical tube, including the bulb, is first made and filled with mercury to the proper height, and the magnetic index is introduced; then the horizontal tube is joined, and the spirits of wine and the horizontal index are introduced. The bulb is then placed in a freezing mixture, in order that the mercury may retreat as far as possible, followed by the spirits of wine. The tube is then sealed, care being taken that the bore shall end in a small rounded chamber; for, if pointed, some of the spirits would be apt to lodge there, whence it would be difficult to remove it. The object of cooling the bulb before sealing off is, that we may have as much air in the tube as possible, for its pressure, as already mentioned, enables the spirits to follow the mercury when the latter falls.

To graduate the instrument, set it with the mercurial stem horizontal in melting ice, then point off the extremity of the mercurial, and also of the spirit column as corresponding to 32° F. Perform a similar operation in water 42°, 52°, 62°, &c., and also in freezing mixtures down to zero, or lower if necessary.

In conclusion, if used as a wet-bulb thermometer, this instrument will give us the maximum and minimum temperatures of evaporation obtained under precisely the same circumstances.

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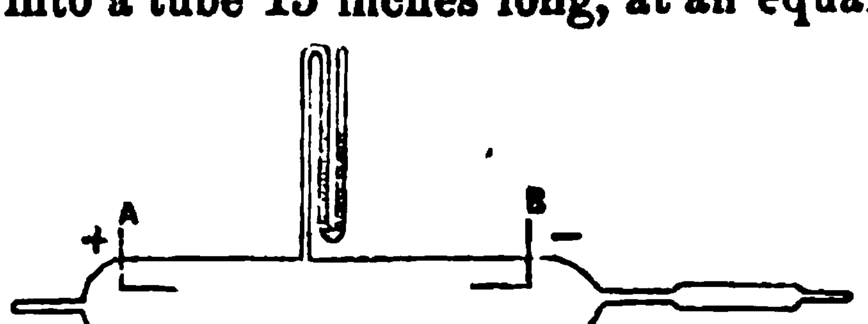
*On Indications of Vacua.**

An interesting paper "On Vacua as Indicated by the Mercurial Siphon-gauge and the Electrical Discharge" was recently read at the Royal Society, by J. P. Gassiot, Esq., F.R.S. The following is an abstract of it:

"That the varied condition of the stratified electrical discharge is due to the relative but always imperfect condition of the vacuum through which it is passed, is exemplified by the changes which take place in the form of the striæ while the potash is heated in a carbonic acid vacuum-tube. In order, if possible, to measure the pressure of the vapor, I had a carefully prepared siphon mercurial gauge sealed into a tube 15 inches long, at an equal distance between the two wires A B. This tube was charged with carbonic acid in the manner described by me in a former communication. When exhausted by the air-pump and sealed, it showed a pressure indicated by about 0·5 inch difference in the level of the mercury; the potash was then heated; the mercury gradually fell until it became perfectly level. Dr. Andrews (*Philosophical Magazine*, February, 1852,) has shown that with a concentrated solution of caustic potassa, he obtained



* From the London Mechanics' Magazine, June, 1860.

with carbonic acid a vacuum with the air pump so perfect as to exercise no appreciable tension, as no difference in the level of the mercury in the siphon-gauge could be detected. On trying the discharge in the vacuum-tube after the potash had cooled, I found it gave the cloud-like stratifications, with a slight reddish tinge; consequently not only was the vacuum not perfect, as denoted by the form of stratifications, but in this tube the color denotes that even a trace of the air remains, probably that portion in the narrow part of the siphon-gauge, which, from its position, was not displaced by the carbonic acid."

"The potash was subsequently heated until the discharge was reduced to a wave line, with very narrow striæ; in this state moisture is seen adhering to the sides of the tube; but even in this state the difference in the level of the mercury in the gauge did not ever vary more than ·05 inch. As the potash cooled, the discharge altered through all the well-known phases of the striæ, the mercury again becoming quite level. At first almost the slightest heat applied to the potash alters the form of the stratifications; as the heating is repeated, longer application is necessary; but it shows how sensibly the electrical discharge denotes the perfection of a vacuum, which cannot be detected by the ordinary method of mercurial siphon-gauge.

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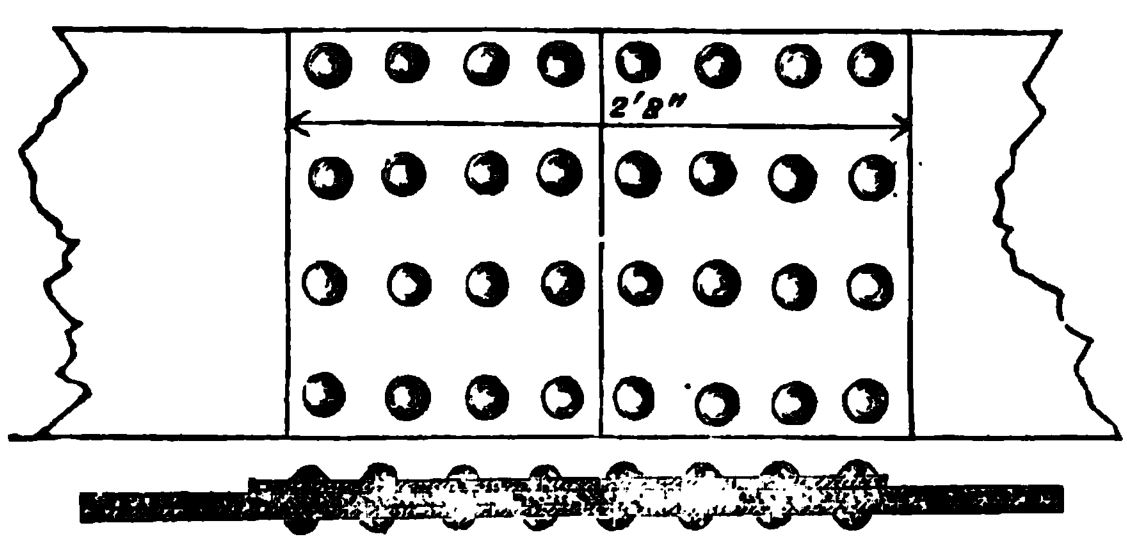
*Chain Riveting.** By W. Fairbairn, Esq., LL.D., F.R.S., &c., &c.

In the formation of the bottom of a tubular girder, whether composed of cells, as in the Britannia and Conway bridges, or of double plates, as in smaller examples, it is of importance to have as few joints as possible. Hence the plates should be rolled as long as their weight and thickness will allow, and the joints be carefully united by covering plates, *chain riveted*, as shown in the following sketch, with three or more rows of rivets, according to the width of the plates. Eight



rivets are required in each of the lines, four on each side of the joint, to give sufficient strength, and the area of the rivets collectively should be equal to the area of the jointed plates, taken transversely through one line of the rivets, the area of the parts punched out in that line being deducted. These proportions give the required security to the joint, and afford nearly the same strength to a tensile strain as the solid plate; that is, if the covering plates be as much thicker as will give the same area of section through the rivet holes as the imperfo-

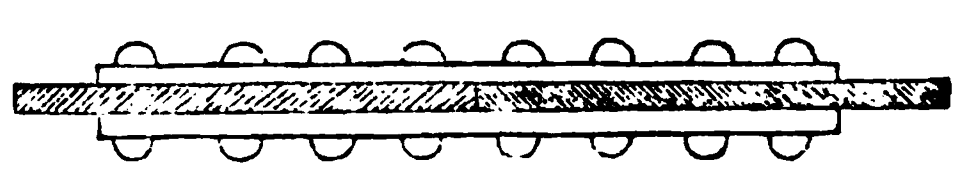
* From the Lond. Mechanics' Magazine, June, 1860.

rated double plate. These precautions being taken in covering the joints of the plates and in securing the angle irons which unite the sides with the bottom, it will meet in practice all the requirements of a uniform power of resistance to strain from one end of the girder to the other.

In a long experimental inquiry which I undertook some years since, it was shown that there was a loss in the riveted joint, as compared with the solid plate, of 30 to 50 per cent.; that is, taking the strength of the solid plate at 100, that of the double riveted joint would be 70, and that of the single riveted joint 50.

This great deficiency in the strength of joints subjected to a transverse strain, caused considerable difficulty in designing the Britannia and Conway bridges; double, treble, and quadruple riveting was thought of; but one after another was abandoned, on account of the rivet holes weakening the plates; and I should almost have despaired of attaining the object in view, but for the system of longitudinal or chain riveting having occurred to me, after repeated trials of other modes and forms. Experiment, however, established the perfect security of this method, as the following tables clearly demonstrate. Two distinct methods were tried, one with a single thickness of plates, the joint having a covering strip on each side; the other with two thicknesses of plate, there being a joint in one of them covered by a plate, and kept in position by a line of rivets as already described. The jointed plates having been prepared, the experiments were effected by a powerful lever, tearing the joints and plates asunder in the direction of the line of rivets.

Chain Riveting. Single Plates, with double Covers over the Joint.

No. of Experiment.	Weight in lbs.	Elongation in inches.	Remarks.
1	5,600		Weight of the lever.
2	26,656		
3	28,448		
4	30,240	·021	
5	32,032	·034	
6	33,824	·034	
7	35,626	·044	
8	37,418	·052	
9	39,210	·056	
10	41,002		Torn asunder through a rivet hole after sustaining the load a few seconds.

			Sq. in.
Area of section through solid plate,	. .	3·5 × ·25	= ·875
Area of the covering plates,	. .	3·5 × ·26	= ·910
Area of section through rivet hole,	. .	3·0 × ·25	= ·750

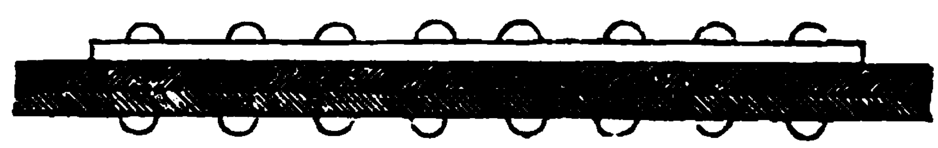
Diameter of the rivets, each ½ inch, four on each side of the joint.

If we take the area of the plate at the point of fracture = ·750 inch, it will be found that it required a power of 24·41 or nearly 24½ tons per square inch to tear it asunder.

From the following experiment, it appears that the fracture took place through the solid plate on one side, and by shearing off the rivets on the other. Hence the area of section of fracture $= \cdot 875 \times \cdot 785 =$ 1·66 inches, and proceeding as before, we have 18·73 tons per square inch as the breaking weight.

Chain Riveting. Double Plates, and a single Cover over the Joints.

No. of Experiment.	Weight in lbs.	Elongation in inches.	Remarks.
1	5,600		Weight of the lever.
2	26,656	·016	
3	37,408	·025	
4	46,368	·028	
5	55,328	·075	
6	62,496	·100	
7	69,664		Broke by shearing off the rivets close to the plate.



		Sq. in.
Area of section through plates,	$2 \times \cdot 875$	$= 1 \cdot 750$
Area of section through rivet holes,		$= 1 \cdot 5$
Area of covering plate through rivet holes,		$= 0\ 91$

Rivets as before, ½-inch diameter.

Finding the resisting powers of the rivets unequal to the strength of the double plates, they were afterwards increased from half an inch to five-eighths of an inch in diameter, or until the area of the rivets approached nearly to the area of the plates, which gave the required strength. In joints of this description it will be found that the resisting powers of the rivets is nearly equal to that of the plates, *i.e.*, the resisting power of the rivet is to that of the plates as their sectional areas respectively. This is an agreement with the following laws, which have been deduced from experiment:—1st, that the ultimate resistance to shearing, in any bolt or rivet, is proportional to the sectional area of the bar torn asunder; and, 2d, that the ultimate resistance of any bar to a shearing strain is nearly the same as the ultimate resistance of the same bar to a direct longitudinal strain.

For the Journal of the Franklin Institute.

Particulars of the Steamer Zouave.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, Sandford's Independent Line, New York to Philadelphia.

Hull.—Length on deck, 220 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. 3 ins. Frames, molded, 14 ins.,—sided, 6 ins.,—24 ins. apart from centres, and strapped with diagonal and double laid braces, $4 \times \frac{1}{2}$ in. One independent steam fire and bilge pump. One bulkhead. Promenade deck with saloon, cabin, and state-rooms. Draft of water forward and aft, 6 ft. 6 ins. Area of immersed section at load draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner. Tonnage, 800 tons.

Engines.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke, 11 ft. Cut-off, one-half.

Boiler—One—Return flued. Length of boiler, 27 ft. Breadth of do., (front) 13 ft. Height of do. exclusive of steam chimney, 11 ft. 3 ins. Number of furnaces, two. Breadth of do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, below, ten—2 of 22½, and 4 each of 15 and 17 ins.—above, twenty—10 each of 8½ and 9½ ins. Length of flues, above, 20 ft. 8 ins., below, 14 ft. Diameter of smoke pipe, 52 ins.

Paddle Wheels—Diameter over-boards, 31 ft. Length of blades, 7 ft. Depth of do., 24 ins. Number of do., 27.

Date of trial, November, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the U. S. Steamer Seminole.

Hull built by United States Government. Machinery by Morgan Iron Works, New York.

Hull.—Length at load line, 200 ft. Breadth of beam (molded), 28 ft. Depth of hold to spar deck, 14 ft. Length of engine room, coal bunkers, &c., 48 ft. Two bulkheads. One independent steam fire and bilge pump. Draft of water forward and aft, 10 ft. Tonnage, 755 tons. Area of immersed section at load draft of 10 ft., 264 sq. ft. Capacity of coal bunkers, 220 tons. Masts, three—Rig, Bark. Speed in knots, 9.

Engines.—Two, horizontal steeple. Diameter of cylinders, two of 50 ins. Length of stroke, 2 ft. 6 ins. Maximum pressure of steam, 50 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 80.

Boilers—Two, and one donkey. Vertical tubular. Length of boilers, 22 ft. Breadth of do., 10 ft. 6 ins. Height of do. exclusive of steam chimney, 10 ft. 3 ins. Number of furnaces. 12. Breadth of do., 3 ft. Length of grate bars, 5 ft. 6 ins. Number of tubes, 3685. Internal diameter do., 2 ins. Length do., 2 ft. 7¼ ins. Diameter of smoke pipe, 6 ft. Height of do., 42 ft.

Propeller.—Diameter of screw, 9 ft. 6 ins. Pitch of do., 18 ft. Number of blades, two.

Date of trial, May, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer New Brunswick.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, International Steam-ship Company. Intended service, Portland to St. Johns, N. B.

Hull.—Length on deck, 224 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 24 ins. and strapped with diagonal and double laid braces, 4×½ in. Independent steam fire and bilge pumps. Promenade deck with saloon, cabin, and state-rooms. One bulkhead. Draft of water, forward and aft, 6 ft. 6 ins. Tonnage, 815 tons. Area of immersed section at draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner.

Engine.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke, 11 ft. Cut-off, variable.

Boiler—One—Return flued. Length of boiler, 26 ft. 2 ins. Breadth, front, 13 ft. Height, exclusive of steam chimney, 11 ft. 6½ ins. Number of furnaces, two. Breadth do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, above, 6, below, 10. Internal diameter of flues, above, 1 ft. 5 ins., below, 2 of 22½ ins., and four each of

15 and 17 ins. Length of flues, above, 18 feet 6½ ins., below, 13 feet 2 ins. Diameter of smoke pipe, 4 feet 4 ins.

PADDLE WHEELS.—Diameter, over boards, 31 feet. Length of blades, 7 feet. Depth do., 22 ins. Number do., 27.

Date of trial, October, 1860. C. H. H.

Translated for the Journal of the Franklin Institute.

On the Elastic Force of Vapors. By M. V. REGNAULT.

"I presented to the Academy, in August, 1854, the principal results of the experiments which I had made to determine the laws which exist between the elastic forces of vapors and the temperatures to which they are subjected. This work is a portion of a long series of investigations, the first part of which was published in 1845,* the principal object of which is to collect the physical elements necessary to calculate the theoretical work which can be obtained from a substance, either when it is transformed into an elastic fluid by means of a known quantity of heat, or when the elastic fluid, losing a certain quantity of heat, develops a known moving power, either in resuming the liquid state as in the condensing steam engine, or simply in increasing in volume, as occurs in high pressure steam engines and in hot-air engines.

"The law which connects the elastic forces of gases and vapors with their temperature necessarily plays an important part in this general question. Moreover, it appears that it ought to be one of the simplest of the theory of heat, because it depends only upon two elements which are clearly defined and susceptible of precise determination, the temperatures and the pressures which the elastic forces balance.

"This announcement will explain the interest which I attached to an investigation of this sort, and the perseverance with which I collected its elements. In fact, my work extends from gases which have been liquefied by compression, to substances, such as mercury and sulphur, whose boiling-points are not so high but that they may be kept in ebullition, under high pressures, in apparatus which can now be constructed.

"The Memoir which includes the whole of these observations has been printed for several years; it forms a part of vol. xxvi, of the Memoirs of the Academy. The publication has been delayed by circumstances beyond my control, and particularly by the necessity of myself tracing upon the plate, as I did for steam (*Memoirs of the Academy*, vol. xxi,) the points determined by each separate experiment, and the curves which exhibit their connexion.

"This Memoir, as I announced in 1854 (*Comptes Rendus*, vol. xxxix, pp. 301, 345, 397), is divided into five parts:

"1st. The first includes my examinations into the elastic forces of saturated vapors through a great range of temperatures.

"2d. The second treats of the elastic forces of vapors emitted by saline solutions, and of their boiling-point under different pressures.

* See Journ. Frank. Inst., present series, vols. xv, xvi, and xvii.

"3d. In the third, I study the elastic forces of these same vapors in the air and in other gases.

"4th. The fourth treats of the elastic forces of vapors from two volatile liquids, either dissolved in one another, or simply superposed when they exercise no mutual dissolving action.

"5th. Finally, in the fifth, I endeavor to determine whether the solid or liquid state of the same body exercises any influence for the same temperature over the elastic force of the vapor which it emits.

"I shall not here again allude to the last four parts of the Memoir; the general conclusions which I thought could be drawn from my experiments appear to be sufficiently expressed in the *Comptes Rendus* of 1854. I ask of the Academy only the permission to give it some developments of the first part, that which treats of the elastic forces of saturated vapors *in vacuo*, of which I could cite but a few examples in my communication in 1854.

"The various apparatus which I used in these researches are described in the Memoir; I shall not dwell upon them; remarking only that they are referable to two different methods.

"The first, which I call the *statical method*, consists in determining the pressure which equilibriates the elastic force of the vapor, *at rest*, which a liquid in excess emits at various temperatures. In the second method, which I call the *dynamical method*, the vapor is always in motion, and we determine the temperature of the vapor which the liquid *continually* emits when boiling under different pressures.

"These two methods give results which are identical:

"1st. When the liquid is perfectly homogeneous. It is not so when it is impure; the presence of the smallest quantity of a volatile foreign body shows itself immediately by the non-superposition of the two graphical curves belonging to the two methods.

"2d. When the liquid has not a great molecular attraction. In the opposite case the liquid boils intermittently with violent starts, and the determinations by the dynamical method become very uncertain.

"The two methods could be successfully applied to the greater part of the volatile substances which were submitted to my experiments, and they have enabled me to determine their elastic forces from the lowest temperatures up to those which correspond to pressures of from 12 to 15 atmospheres. The greatest part of the gases liquified by pressure give liquids which possess great molecular attraction and resist ebullition notwithstanding their extreme mobility. Their elastic forces can only be certainly determined by the statical method. When we wish to apply the dynamic method, the thermometer cannot be placed in the vapor of the boiling liquid unless the boiling-point is above the temperature of the surrounding air; for if it be inferior, the vapor may become overheated, and the indications of the thermometer will be wrong. If the thermometer is placed in the boiling liquid, it does not show a constant temperature during ebullition, although the pressure remains the same. The indications of the thermometer change much according to the manner in which the heat is applied. The boiling is not continuous; it takes place with violent

shocks, which are attended by a sharp noise like that of the water-hammer when it is suddenly inverted. These effects vary much with the pressure under which the boiling takes place. Certain liquids present them even under pressures below that of the atmosphere; in others they appear only under high pressures.

"The limits to which I am obliged to confine myself in this *résumé*, do not allow me to state the individual observations which I have made on each substance, nor even to explain the method of graphical construction, nor the formulæ of interpolation by which I endeavored to express the results of my experiments in the best way. I will remark only, that of all the modes of interpolation which were successively tried, the formula by exponential series, proposed by De Prony and applied by M. Biot, to the vapor of water under the form

$$\text{Log. } F = a + b\alpha^t + c\beta^t$$

is the one which applied most exactly to all the substances studied. This formula has, besides the advantage of containing five constants, for the determination of which, five points of the graphic curve, having equidistant abscissæ, may be selected, so that the curve represented by the formulæ can vary but very little from the curve traced through the intermediate points. Moreover, I show in my Memoir that for a great number of the substances studied, we may, by a convenient adjustment of the fixed points which serve to calculate the constants, without sensibly departing from the data of direct observation, calculate a formula with two exponentials

$$\text{Log. } F = a + b\alpha^t + c\beta^t,$$

in which the term $c\beta^t$ introduces only quantities less than the errors of observation, so that it may be reduced to the more simple one,

$$\text{Log. } F = a + b\alpha^t.$$

"This consideration and the great resemblance which the curves traced for the different substances have to each other, when the ordinate is taken equal to $\frac{F}{760}$, leads me to think that the law of the elastic forces and temperatures would present itself under a very simple form, if for the variable independent we should assume not the temperature as we define it in an entirely arbitrary manner, but another element which should be immediately connected with the constitution of each body, and whose origin should be fixed for each one of them.

"I have in the following tables presented the elastic forces of the different vapors, calculated for temperatures varying by 5°, according to the formulæ which I calculated from my experiments. The temperatures are those of the mercurial thermometer which I used. In my Memoir, I also give the corresponding temperatures taken by the air thermometer. The reduction of the temperatures from the mercurial to the air thermometer was determined by especial experiments.

TABLE No. 1.

Liquids of Mean Volatility. Boiling-Point between 14° and 150° Cent.

	ALCOHOL.	ETHER.	SULPHURET OF CARBON.	CHLOROFORM	BENZINE.	CHLORIDE OF CARBON. $C_2\ Cl_8$.
T.	F.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.	mm.
— 25					2,37	
— 20	3,34	67,49	43,48		4,94	
— 15	4,69	87,89	60,91		8,62	
— 10	6,58	113,35	81,01		13,36	
— 5	9,21	144,82	104,40		19,30	
0	12,83	183,34	131,98		26,62	30,55
+ 5	17,73	230,11	164,53		35,60	40,09
10	24,30	286,40	203,00		46,59	52,08
15	33,02	353,62	248,40		60,02	67,09
20	44,48	433,26	301,78	160,47	76,34	85,49
25	59,35	526,93	364,24	199,40	96,09	107,94
30	78,49	636,33	436,97	245,91	119,89	135,12
35	102,87	763,27	521,36	301,13	148,37	167,73
40	133,64	909,59	616,99	366,20	182,27	206,51
45	172,14	1077,22	729,72	442,37	222,37	252,31
50	219,88	1271,12	856,71	530,96	269,51	305,39
55	278,61	1484,59	1000,87	633,36	324,61	367,68
60	350,26	1728,52	1163,73	751,01	388,62	439,66
65	436,99	2002,13	1346,86	885,41	462,57	522,26
70	541,21	2307,81	1551,84	1038,09	547,51	616,48
75	665,52	2647,75	1780,28	1210,62	644,59	723,29
80	812,76	3024,41	2033,77	1404,57	756,63	843,70
85	985,97	3440,30	2313,90	1621,52	879,55	978,71
90	1188,43	3898,05	2622,23	1863,12	1019,96	1129,04
95	1423,52	4400,55	2960,30	2130,90	1177,10	1296,47
100	1694,92	4950,81	3329,54	2426,52	1352,27	1481,19
105	2006,34	5552,18	3731,37	2751,23	1546,59	1684,45
110	2361,63	6208,37	4167,18	3106,83	1761,29	1907,21
115	2764,74	6923,55	4638,14	3494,69	1997,48	2150,47
120	3219,68	7702,20	5145,43	3916,17	2256,26	2415,23
125	3730,41		5690,08	4372,73	2538,66	2702,54
130	4301,04		6273,03	4865,65	2845,66	3013,49
135	4935,40		6895,06	5396,23	3178,18	3349,28
140	5637,00		7556,88	5965,76	3537,05	3711,23
145	6410,62			6575,41	3923,00	4100,81
150	7258,73			7226,49	4336,70	4519,73
155	8185,02			7920,19	4778,69	4969,97
160				8657,72	5249,43	5453,88
165				9440,40	5749,26	5974,28
170					6278,40	6534,58
175					6837,04	7138,90
180					7425,66	7792,33
185					8042,41	8501,02
190						9272,67
195						10116,74

TABLE No. 1 (Continued).

LIQUIDS OF MEAN VOLATILITY. BOILING-POINT BETWEEN 14° AND 150° CENT.

	CHLORHYDRIC ETHER.	BROMHYDRIC ETHER.	IODOHYDRIC ETHER.	METHYLIC ALCOHOL.	ACETONE.
T.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.
— 30	110,24				
— 25	145,01				
— 20	187,55			6,27	
— 15	239,60			9,29	
— 10	302,09			13,47	
— 5	376,72			19,17	
0	465,18		41,95	26,82	
+ 5	569,32		54,14	36,89	
10	691,11		69,20	50,13	
15	832,56		87,64	67,11	
20	996,23	380,30	110,02	88,67	197,89
25	1184,17	463,30	136,95	115,99	226,27
30	1398,99	559,81	169,07	149,99	281,00
35	1643,24	671,31	207,09	192,01	345,15
40	1619,58	799,35	251,73	243,51	420,15
45	2230,71	945,56	303,77	306,13	507,52
50	2579,40	1111,65	364,00	381,68	602,86
55	2668,43	1299,41	433,21	472,20	725,95
60	3400,54	1510,69	512,25	579,93	860,48
65	3878,52	1747,43		707,33	1014 32
70	4405,03	2011,57		857,10	1189,38
75	4982,72	2305,24		1032,14	1387,62
80	5614,11	2630,45		1238,47	1611,05
85	6301,61	2989,38		1470,92	1861,81
90	7047,51	3384,22		1741,67	2141,66
95	7853,92	3817,11		2051,71	2452,81
100	8722,76	4290,33		2405,15	2797,27
105		4806,11		2806,27	3177,00
110		5366,67		3259,60	3593,96
115		5974,26		3769,80	4050,02
120		6631,08		4341,77	4546,86
125		7339,33		4980,55	5086,25
130		8101,15		5691,30	5669,72
135		8918,64		6479,32	6298,68
140		9793,86		7337,10	6974,43
145				8308,87	
150				9361,35	

TABLE No. 2.

LIQUIDS BOILING ABOVE 150° CENT.

ESSENCE OF TURPENTINE.		ESSENCE OF LEMON.		METHYLOXALIC ETHER.	
T.	F.	T.	F.	T.	F.
°	mm.	°	mm.	°	mm.
0	2,07	98,99	69,80	109,41	117,26
10	2,94	115,40	129,39	109,53	117,46
20	4,45	115,10	129,09	125,98	222,67
30	6,87	124,85	178,31	126,06	222,87
40	10,80	125,03	179,01	136,45	320,11
50	16,98	137,00	263,42	145,14	423,37
60	26,46	147,35	357,04	155,70	591,36
70	40,64	155,52	449,23	164,30	761,35
80	61,30	165,08	576,50	188,92	1589,81
90	90,61	174,25	748,67	192,37	1589,81
100	131,11	174,16	749,69	217,16	2958,68
110	185,62	201,60	1439,68	228,95	3875,95
120	257,21	223,30	2328,04	237,16	4849,72
130	348,98	236,65	3213,49	164,48	763,48
140	464,02	239,70	4374,42	242,86	4867,83
150	605,20			253,53	6203,14
155	686,37				
160	775,09				
165	871,27				
170	975,42				
175	1090,11				
180	1207,92				
185	1336,45				
190	1473,24				
195	1618,26				
200	1771,47				
The experiments on the essence of turpentine were carried to much heavier pressures, but I judged it useless to transcribe them here, because they had reference only to an essence completely modified in its molecular constitution. I have in my Memoir described the series of researches by which I studied the isomeric modifications which the essence successively undergoes by its boiling under various pressures.		When these experiments were ended, the essence of lemon showed the same boiling-point at atmospheric pressure as before, but it had completely lost its power of rotating polarized light.		The boiling of methyloxalic ether is pretty steady under pressures but little above that of the atmosphere, but under heavy pressures it becomes very irregular, and produces violent starts.	

TABLE No. 3.

	MERCURY.
T.	F.
°	mm.
0,0	0,0200
10	0,0268
20	0,0372
30	0,0530
40	0,0767
50	0,1120
60	0,1643
70	0,2410
80	0,3528
90	0,5142
100	0,7455
110	1,0734
120	1,5341
130	2,1752
140	3,0592
150	4,2664
160	5,9002
170	8,0912
180	11,00
190	14,84
200	19,90
210	26,35
220	34,70
230	45,35
240	58,82
250	75,75
260	96,73
270	123,01
280	155,17
290	194,46
300	242,15
310	299,69
320	368,73
330	450,91
340	548,35
350	663,18
360	797,74
370	954,65
380	1136,65
390	1346,71
400	1587,96
410	1863,73
420	2177,53
430	2533,01
440	2933,99
450	3384,35
460	3888,14
470	4449,45
480	5072,43
490	5761,32
500	6520,25
510	7353.44
520	8264,96

Note to Table 3.

"The temperatures here recorded are those of the air-thermometer. The boiling of the mercury is pretty steady under pressures below that of the atmosphere. At the atmospheric pressure the starts begin; they become more and more violent as the pressures augment, and under the pressure of 10 atmospheres the shocks are so strong as to produce a noise as loud as that of a forge-hammer striking upon the anvil. The apparatus appeared in danger of flying in pieces.

TABLE No. 4.

VERY VOLATILE LIQUIDS, LIQUEFIED GASES.

	SULPHUROUS ACID.	AMMONIA.	SULPHYDRIC ACID.
T.	F.	F.	F.
°	mm.	mm.	mm.
—78,2		157,95	441,42
—40		528,61	
—35		684,19	
—30		876,58	2808,57
—25	373,79	1112,12	3508,02
—20	479,46	1397,74	4273,01
—15	607,90	1740,91	5090,18
—10	762,49	2149.52	5945,00
— 5	946,90	2632,25	6822,74
0	1165,06	3162,87	7709,27
+ 5	1421.14	3854,47	
10	1719,55	4612,19	
15	2064,90	5479,26	
20	2462,05	6467,00	
25	2915,97	7581,16	
30	3431,80	8832,20	
35	4014,78	10144,00	
40	4670,23	11776,42	
45	5403,52		
50	6220,01		
55	7125,02		
60	8123,80		
65	9221,40		

"The condensation of the gases was effected in the same apparatus which was to serve for the determination of the elastic forces, and which was so arranged that it could be completely purged afterwards of every trace of air or other gas which might be in it. The liquefaction of sulphurous acid was easily effected under the ordinary pressure of the atmosphere when the apparatus was plunged into a freezing mixture. For ammonia and sulphuretted hydrogen, the apparatus was plunged into a mixture of ice and crystallized chloride of calcium, and the gas was then compressed by a hand-pump. Only, care must be taken to replace the ordinary grease for the pump by fixed non-saponifiable oils. A pressure of 2 or 3 atmospheres is sufficient to liquefy as much ammonia as is desired; but for sulphuretted hydrogen the pressure must be carried to 7 or 8 atmospheres.

"As I have had occasion to liquefy these gases on a large scale for researches of which I will soon present the results to the Academy, and especially for the determination of the latent heat of volatilization under different pressures of very volatile liquids, and for the examination of the quantities of heat which their vapors absorb during their expansion, I will here briefly indicate the process which I employed.

"I prepare carbonic acid gas by supplying in a continuous and regular stream, properly-diluted chlorhydric acid to fragments of marble enclosed in a very large glass vessel. The solution deprived of the acid and charged with chloride of calcium flows out as fast as it forms; the carbonic acid gas passes over to a gas receiver of a cubic capacity of 1 cubic metre. A condensing-pump with several barrels, moved by my steam engine, draws the gas from the receiver, and having caused it to pass over drying materials, it forces it into a first recipient of 3 or 4 litres capacity which serves only as a regulator; thence, the gas passes freely into the apparatus in which it is to be condensed, which is buried in a freezing mixture of ice and crystallized chloride of calcium. The gas which does not condense, passes into a second closed recipient of 5 litres capacity. Into this last vessel, the air and other more condensable gases pass, and from it they may from time to time be discharged by opening a stop-cock.

"The same arrangement will serve to liquefy large quantities of protoxide of nitrogen, or sulphuretted hydrogen. But for these gases which are easily rendered impure by contact with the grease and pistons of the pump, I employ a peculiar forcing-pump, in which the gas is in contact only with mercury. This pump is composed of two equal cast iron cylinders, united in the form of a U. The first cylinder is turned, and contains a solid piston which, in its movement, acts only on a quantity of mercury which fills exactly one of the pump cylinders. The suction and compressing (foot and head) valves are attached to the second cylinder. It will be seen that by this arrangement the gas never comes into contact with the piston or the greasy sides.

"Liquid ammonia particularly occupied my attention, owing to its great capacity for heat, its great latent heat of evaporation, and the ease with which it is prepared and collected after it has assumed the

gaseous state. I determined to use it principally for obtaining very stationary low temperatures by boiling it under different pressures. I prepare the ammonia as a gas by passing continuously a thread of a concentrated solution of ammonia into a copper tube enclosed in a small boiler containing water which is kept boiling by a gas-light. The ammonia flows in a spiral along the walls, and the liquid, nearly deprived of ammonia, escapes by a tube below, which enters to a depth of several decimetres into the liquid which has previously flowed out.

"The gaseous ammonia, sucked by the pump, traverses several copper recipients filled with soda-lime. The pump itself regulates the production of the gas, and delivers it into the receiver, which is buried in a freezing mixture of ice and hydrated chloride of calcium. By means of this arrangement several litres (quarts) of liquid ammonia may be obtained in a few hours.

"To submit an apparatus to a stationary low temperature, it is hermetically adjusted in the condenser, and the liquid ammonia is condensed in this receiver buried in a freezing mixture. When it is sufficiently filled with the liquid, the freezing mixture is removed and the receiver placed in communication with one of my large air-reservoirs, in which the pressure is kept rigorously stationary, either above or below that of the atmosphere.

"The ammonia thus distils under pressures as light as are desired, which are easily kept perfectly constant, provided the ammoniacal gas is prevented from reaching the air-reservoir. For this purpose, in front of this reservoir is placed a cylindrical vessel containing pieces of ice, which, as they liquefy, almost entirely re-dissolve the ammonia; and after this, another cylinder filled with large pieces of pumice stone soaked with acid.

"I thus hoped to obtain, by means of this apparatus, low temperatures which should be perfectly stationary, but I was not successful for reasons which I have explained before (p. 242). A certain amount of steadiness can only be obtained by passing a continual current of small bubbles of air through the liquid ammonia, which thus continually stirs up the liquid and destroys its viscosity. An air thermometer should be placed in contact with the apparatus experimented on, and plunged entirely in the liquid ammonia; by means of a regulating screw, the current or air-bubbles is controlled so as to keep the thermometer stationary.—*Comptes Rendus de l'Academie des Sciences de Paris*, 11 *Juin*, 1860.

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*On Microscopic Vision and a new Form of Microscope.** By Sir. D. Brewster.

In studying the influence of aperture on the images of bodies as formed in the camera, by lenses or mirrors, it occurred to me that in microscopic vision it might exercise a still more injurious influence. Opticians have recently exerted their skill in producing achromatic object-glasses for the microscope with large angles of aperture. In 1848 the late distinguished optician, Mr. Andrew Ross, asserted "that

* From the Lond. Athenæum, July, 1860.

135° was the largest angular pencil that could be passed through a microscopic object-glass," and yet in 1855 he had increased it to 170°, while some observers speak of angular apertures of 175°. In considering the influence of aperture, we shall suppose that an achromatic object-glass with an angle of aperture of 170° is optically perfect, representing every object without color and without spherical aberration; when the microscopic object is a cube, we shall see five of its faces, and when it is a sphere or a cylinder, we shall see nine-tenths or more of its circumference. How, then, does it happen that large apertures exhibit objects which are not seen when small apertures with the same focal length are employed? This superiority is particularly shown with test objects marked with grooves or ridges and obliquely illuminated. The marginal part of the lens will enlarge the grooves and ridges, and they will thus be rendered visible, not because they are seen more distinctly, but because they are expanded by the combination of their incoincident images. Hence we have an explanation of the fact—well known to all who use the microscope—that objects are seen more distinctly with object-glasses of small angular aperture. In the one case we have, with the same magnifying power, not only an enlarged and indistinct image of objects, but a false representation of them, from which their true structure cannot be discovered; while in the other we have a smaller and distinct image, and a more correct representation of the object. But these are not the only objections to large angular apertures and short focal lengths. 1. In the first place, it is extremely difficult to illuminate objects when so close to the object-glass. 2. There is a great loss of light, from its oblique incidence on the surface of the first lens. 3. The surface of glass,—with the most perfect polish,—must be covered with minute pores, produced by the attrition of the polishing powder; and light, falling upon the sides of these pores with extreme obliquity, must not only suffer diffraction, but be refracted less perfectly than when incident at a less angle. 4. When the object is almost in contact with the anterior lens, the microscope is wholly unfit for researches in which mechanical or chemical operations are required, and also for the examination of objects inclosed in minerals or other transparent bodies. 5. In object-glasses now in use, the rays of light must pass through a great thickness of glass of doubtless homogeneity. It is a question yet to be solved whether or not, a substance can be truly transparent, in which the elements are not united in definite proportion; in which the substances combined have very different refractive and dispersive powers; and in which the particles are so loosely united that they separate from one another, as in the various kinds of decomposition to which glass is liable. If the best microscopes are affected by these sources of error, every exertion should be made to diminish or remove them. 1. The first step, we conceive, is, to abandon large apertures, and to use object-glasses of moderate focal length, obtaining at the eye-glass any additional magnifying power that may be required. 2. In order to obtain a better illumination, either by light incident vertically or obliquely, a new form of the microscope would be advantageous. In place

of directing the microscope to the object itself, placed as it now is, almost touching the object-glass, let it be directed to an image of the object, formed by the thinnest achromatic lens, of such a focal length that the object may be an inch or more from the lens, and its image equal to, or greater, or less than the object. In this way the observer will be able to illuminate the object, whether opaque or transparent, and may subject it to any experiments he may desire to make upon it. It may thus be studied without a covering of glass, and when its parts are developed, by immersion in a fluid. 3. The sources of error arising from the want of perfect polish and perfect homogeneity of the glass of which the lenses are composed, are, to some extent, hypothetical; but there are reasons for believing,—and these reasons corroborated by facts,—that a body whose ingredients are united by fusion, and kept in a state of constraint from which they are striving to get free, cannot possess that homogeneity of structure, or that perfection of polish, which will allow the rays of light to be refracted and transmitted without injurious modification. If glass is to be used for the lenses of microscopes, long and careful annealing should be adopted, and the polishing process should be continued long after it appears perfect to the optician. We believe, however, that the time is not distant when transparent minerals, in which their elements are united in definite proportions, will be substituted for glass. Diamond, topaz, and rock crystal are those which appear best suited for lenses. The white topaz of New Holland is particularly fitted for optical purposes, as its double refractions may be removed by cutting it in plates perpendicular to one of its optical axes. In rock crystal the structure is, generally speaking, less perfect along the axis of double refraction than in any other direction, but this imperfection does not exist in topaz.—Prof. Stokes and Mr. Stoney suggested some modifications of Sir David Brewster's theoretic views; and a member of the Section whose name we did not catch, stated that several attempts had been made to form an image of objects more removed from the first or object-glass of the microscope than at psesent, by using an additional lens, but hitherto without success.—*Proc. Brit. Assoc.*, 1860.

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*On some Optical Illusions connected with the Inverson of Perspective.**

By Sir D. Brewster.

The term "Inversion of Perspective" has been applied to a class of optical illusions, well known and easily explained, in which depressions are turned into elevations, and elevations into depressions. One of the most remarkable cases of this kind, which has not yet been explained, presented itself to the late Lady Georgiana Wolf, and has been recorded by her husband, Dr. Wolf. When she was riding on a sand-beach in Egypt, all the foot-prints of horses appeared as elevations, in place of depressions, in the sand. No particulars are men-

* From the Lond. Athenæum, July, 1860.

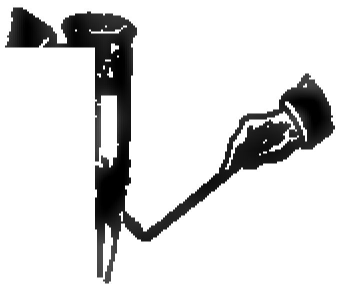
tioned, in reference to the place of the sun, or the nature of the surrounding objects, to enable us to form any conjecture respecting the cause of this phenomenon. Having often tried to see this illusion, I was some time ago so fortunate as not only to observe it myself, but to show it to others. In walking along the west sands of St. Andrew's, the foot-prints, both of men and of horses, appeared as elevations. In a short time they sank into depressions, and subsequently rose into elevations. The sun was at this time not very far from the horizon, on the right hand; and on the left there were large waves of the sea breaking into very bright foam. The only explanation which occurred to me was, that the illusion appeared when the observer supposed that the foot-prints were illuminated with the light of the breakers, and not by the sun. Having, however, more recently observed the phenomenon, when the sun was very high on the right, and the breakers on the left very distant, and consequently very faint, I could not consider the preceding explanation as well founded. Upon attending to the circumstances under which they were now seen, I observed that the human foot-prints were all covered with dry sand that had been blown into them, so that they were much brighter than the surrounding sand, and the dark side of the impression next the sun; and hence it is probable that they appeared to be nearer the eye than the dark sand in which they were formed, and consequently elevations. After repeated examinations of them, I found the foot-prints appeared as elevations as far as the eye could see them; and they were equally visible with one or both eyes. But whenever the eye rested for a little while on the nearest foot-print, it resumed its natural concavity. I have observed other illusions of this kind which are more easily explained, though they differ from any hitherto described. In the Church of Sant' Agostino in Rome, there is above each arch a painted festoon suspended on two short pillars; but, instead of appearing in relief, as the painter intended by shading one side of them, they appeared concave like an intaglio. In other positions in the church they rose into relief. Upon a subsequent visit to the church, I found that the festoon or suspended wreath was concave when it was illuminated—or rather when the observer saw that it was illuminated—by a window beneath it, and in relief when the eye saw that it was illuminated by a window above it, the object being similarly illuminated in both cases. In the common cases of inverted perspective, the eye is deceived by looking at the inversion of the shadow in the cameo or intaglio itself; but in the present case the eye is deceived by perceiving that the body-painting, supposed to be in relief, is illuminated by a light either above or below it. An optical illusion of a different kind presented itself to me in the Church of Santa Giustina at Padua. Upon entering the church we see three cupolas. The one beneath which we stood appeared very shallow; the next appeared much deeper, and the third deeper still. They were all, however, of the same depth, as we ascertained by placing ourselves under each in succession, and observing that it was always the shallowest.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. FARADAY, D.C.L., F.R.S.

LECTURE IV. (Jan. 5, 1860.)—*Chemical Affinity.—Heat.*

We shall have to pay a little more attention to the forces existing in water before we can have a clear idea on the subject. Besides the attraction which there is between its particles to make it hold together as a liquid or a solid, there is also another force, different from the former; —one which, by means of the voltaic battery, we yesterday overcame, drawing from the water two different substances, which, when heated by means of the electric spark, attracted each other, and rushed into combination to reproduce water. Now, the best thing I can do to-day is to continue this subject, and trace the various phenomena of chemical affinity; and for this purpose, as we yesterday considered the character of oxygen, of which I have here two jars (oxygen being those particles derived from the water which enable other bodies to burn), we will now consider the other constituent of water, and without embarrassing you too much with the way in which these things are made, I will proceed now to show you our common way of making *hydrogen*. (I called it hydrogen yesterday—it is so called because it helps to generate water.)† I put into this retort some zinc, water, and oil of vitriol, and immediately an action takes place which produces an abundant evolution of gas now coming over into this jar, and bubbling up in appearance exactly like the oxygen we obtained yesterday.

Fig. 1.

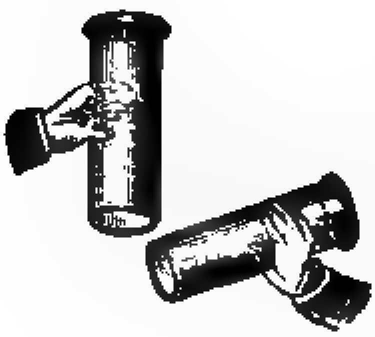


The processes, you see, are very different, though the result is the same in so far as it gives us certain gaseous particles. Here, then, is the hydrogen; I showed you yesterday certain qualities of this gas, now let me show you some other qualities. It is a combustible substance, not like the oxygen which is a supporter of combustion although it will not burn. There is a jar full of it, and if I carry it along in this manner and put a light to it, I think you will see it take fire, not with a bright light,—you will, at all events, hear it if you do not see it. Now, that is a body entirely different from oxygen; it is extremely light; for although you yesterday saw twice as much of this hydrogen produced on the one side as the other, by the voltaic battery, it was only one-eighth the weight of the oxygen. I carry this jar upside

* From the Lond. Chemical News, No. 8. † ὕδωρ, "water," and γεννάω, "I generate."

down. Why? Because I know that it is a very light body, and that it will continue in this jar upside down quite as effectually as the water will in that jar which is not upside down; and just as I can pour water from one vessel into another in the right position to receive it, so can I pour this gas from one jar into another when they are upside down. See what I am about to do,—there is no hydrogen in this jar at present, but I will gently turn this jar of hydrogen up under this other jar (Fig. 2) and then we will examine the two. We shall see, on applying a light, that the hydrogen has left the jar in which it was at first, and has poured upwards into the other, and there we shall find it.

Fig. 2.



You now understand that we can have particles of very different kinds, and that they can have different bulks and weights; and there are two or three very interesting experiments which serve to illustrate this. For instance, if I blow soap bubbles with the breath from my mouth you will see them fall, because I fill them with common air, and the water which forms the bubble carries it down. But now if I inhale hydrogen gas into my lungs (it does no harm to the lungs, although it does no good to them), see what happens. [The Lecturer inhaled some hydrogen, and after one or two ineffectual attempts, succeeded in blowing a splendid bubble, which rose majestically and slowly to the ceiling of the theatre, where it burst.] That shows you very well how light a substance this is; for notwithstanding all the heavy bad air from my lungs, and the weight of the bubble, you saw how it was carried up. I want you now to consider this phenomenon of weight as indicating how exceedingly different particles are one from the other; and I will take as illustrations these very common things, air, water, the heaviest body—platinum—and this gas, and observe how they differ in this respect; for if I take a piece of platinum of that size (Fig. 3) it is equal to the weight of portions of water, air, and hydrogen of the bulks I have represented in these spheres; and this illustration gives you a very good idea of the extraordinary difference with regard to the gravity of the articles having this enormous difference in bulk. [The following tabular statement having reference to this illustration appeared on the diagram board.]

Fig. 3.

Hydrogen, . .	1		
Air, . .	14·4	1	
Water, . .	11940	829	1
Platinum, . .	256774	17831	21·5

Whenever oxygen and hydrogen unite together they produce water, and you have seen the extraordinary difference between the bulk and appearance of the water so produced and the particles of which it consists chemically. Now we have never yet been able to reduce either oxygen or hydrogen to the liquid state; and yet their first impulse when chemically combined is to take up first this liquid condition and then the solid condition. We never combine these different particles together without producing water; and it is curious to think how often you must have made the experiment of combining oxygen and hydrogen to form water without knowing it. Take a candle, for instance, and a clean silver spoon (or a piece of clean tin will do), and if you hold it over the flame you immediately cover it with a dew—not a smoke—which presently evaporates. This perhaps will serve to show it better. Mr. Anderson will put a candle under that jar, and you will see how soon the water is produced (Fig. 4). Look at that dimness on the sides of the glass, which will soon produce drops and trickle down into the plate. Well, that dimness and these drops are *water*, formed by the union of the oxygen of the air with the hydrogen existing in the wax of which that candle is formed.

Fig. 4.

And now, having brought you in the first place to the consideration of chemical attraction, I must enlarge your ideas so as to include all substances which have this attraction for each other—for it changes the character of bodies, and alters them in this way and that way, in the most extraordinary manner; and produces other phenomena wonderful to think about. Here is some chlorate of potash, and there is some sulphuret of antimony. We will mix these two different sets of particles together, and I want to show you in a general sort of way, some of the phenomena which take place when we make different particles act together. Now I can make these bodies act upon each other in several ways. In this case I am going to apply heat to the mixture, but if I were to give it a blow with a hammer the same result would follow. [A lighted match was brought to the mixture, which immediately exploded with a sudden flash, evolving a dense white smoke.] There you see the result of the action of chemical affinity, overcoming the attraction of cohesion of the particles. Again, here is a little sugar, quite a different substance from the black sulphuret of antimony, and you shall see what takes place when we put the two together. [The mixture was touched with sulphuric acid, when it took fire and burnt gradually and with a brighter flame than in the former instance.] Observe this chemical affinity! traveling about the mass, and setting it on fire, and throwing it into such wonderful agitation.

I must now come to a few circumstances which require careful consideration. We have already examined one of the effects of this chemical affinity—but to make the matter more clear we must point out some others. And here are two salts dissolved in water. They are

both colorless solutions, and in these glasses you cannot see any difference between them. But if I mix them, I shall have chemical attraction take place. I will pour the two together into this glass, and you will at once see, I have no doubt, a certain amount of change. Look, they are already becoming milky, but they are sluggish in their action—not quick as the others were—for we have endless varieties of rapidity in chemical action. Now if I mix them together, and stir them so as to bring them properly together, you will soon see what a different result is produced. As I mix them they get thicker and thicker, and you see the liquid is hardening and stiffening, and before long I shall have it quite hard; and before the end of the lecture, it will be a solid stone—a wet stone no doubt, but more or less solid—in consequence of the chemical affinity. Is not this changing two liquids into a solid body a wonderful manifestation of chemical affinity?

There is another remarkable circumstance in chemical affinity, which is that it is capable of either waiting or acting at once. And this is very singular, because we know of nothing of the kind in the forces either of gravitation or cohesion. For instance, here are some oxygen particles, and here is a lump of carbon particles. I am going to put the carbon particles into the oxygen; they *can* act, but they *do* not—they are just like this unlighted candle. It stands here quietly on the table, waiting until we want to light it. But it is not so in this other case: here is a substance, gaseous like the oxygen, and if I put these particles of metal into it the two combine at once. The copper and the chlorine unite by their power of chemical affinity, and produce a body entirely unlike either of the substances used. And in this other case, it is not that there is any deficiency of affinity between the carbon and oxygen, for the moment I choose to put them in a condition to exert their affinity, you will see the difference. [The piece of charcoal was ignited, and introduced into the jar of oxygen, when the combustion proceeded with vivid scintillations.]

Now this chemical action is set going exactly as it would be if I had lighted the candle, or as it is when the servant put coals on and lights the fire: the substances wait until we do something which is able to start the action. Can any thing be more beautiful than this combustion of charcoal in oxygen? You must understand that each of these little sparks is a portion of the charcoal, or the bark of the charcoal, thrown off white-hot into the oxygen, and burning in it most brilliantly as you see. And now let me tell you another thing, or you will go away with a very imperfect notion of the powers and effects of this affinity. There you see some charcoal burning in oxygen. Well, a piece of lead will burn in oxygen just as well as the charcoal does, or indeed better, for absolutely that piece of lead will act at once upon the oxygen as the copper did in the other vessel with regard to the chlorine. And here also is a piece of iron; if I light it and put it into the oxygen, it will burn away just as the carbon did. And I will take some lead and show you that it will burn in the common atmospheric oxygen at the ordinary temperature. These are the lumps of lead which you remember we had the other day—the two pieces which clung

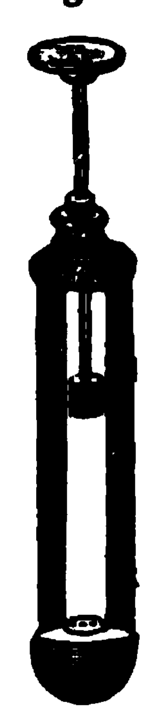
together. Now these pieces, if I take them to-day and press them together, will not stick, and the reason is that they have attracted from the atmosphere a part of the oxygen there present, and have become coated as with a varnish by the oxide of lead which is formed on the surface, by a real process of combustion or combination. There you see the iron burning very well in oxygen, and I will tell you the reason why those scissors and that lead do not take fire whilst they are lying on the table. Here the lead is in a lump, and the coating of oxide remains on its surface, whilst there you see the melted oxide is clearing itself off from the iron, and allowing more and more to go on burning. In this case, however [holding up a small glass tube containing lead pyrophorus], the lead has been very carefully produced in fine powder, and put into a glass tube and hermetically sealed so as to preserve it, and I expect you will see it take fire at once. This has been made about a month ago, and has thus had time enough to sink down to its normal temperature—what you see, therefore, is the result of chemical affinity alone. [The tube was broken at the end, and the lead poured out on to a piece of paper, whereupon it immediately took fire.] Look, look, at the lead burning, why it has set fire to the paper. Now that is nothing more than the common affinity always existing between very clean lead and the atmospheric oxygen; and the reason why this iron does not burn until it is made red-hot, is because it has got a coating of oxide about it which stops the action of the oxygen,—putting a varnish, as it were, upon its surface, as we varnish a picture—absolutely forming a substance which prevents the natural chemical affinity between the bodies from acting.

I must now take you a little further in this kind of illustration, or consideration I would rather call it, of chemical affinity. This attraction between different particles exists also most curiously in cases where they are previously combined with other substances. Here is a little chlorate of potash containing the oxygen which we found yesterday could be procured from it; it contains the oxygen there combined and held down by its chemical affinity with other things; but still it can combine with sugar, as you saw. This affinity can thus act *across* substances, and I want you to see how curiously what we call combustion acts with respect to this force of chemical affinity. Suppose I take a piece of phosphorus and set fire to it, and then place a jar of air over the phosphorus, you see the combustion which we are having there on account of chemical affinity (combustion being in all cases the result of chemical affinity). The phosphorus is escaping in that vapor, which will condense into a snow-like mass at the close of the lecture. But suppose I limit the atmosphere, what then? why, even the phosphorus will go out. Here is a piece of camphor which will burn very well in the atmosphere, and even on water it will float about and burn, by reason of some of it particles gaining access to the air. But if I limit the quantity of air by placing a jar over it, as I am now doing, you will soon find the camphor will go out. Well, why does it go out? not for want of air, for there is plenty of air remaining in the jar. Perhaps you will be shrewd enough to say for want of oxygen.

This therefore leads us to the inquiry as to whether oxygen can do more than a certain amount of work. The oxygen there (Fig. 4) cannot go on burning an unlimited quantity of candle, for that has gone out, as you see; and its amount of chemical attraction or affinity is just as strikingly limited; it can no more be fallen short or exceeded than can the attraction of gravitation. You might as soon attempt to destroy gravitation, or weight, or all things that exist, as to destroy the exact amount of force exerted by this oxygen. And when I pointed out to you that 8 by weight of oxygen to 1 by weight of hydrogen went to form water, I meant this, that neither of them would combine in different proportions with the other, for you cannot get 10 of hydrogen to combine with 6 of oxygen, or 10 of oxygen to combine with 6 of hydrogen—it must be 8 of oxygen and 1 of hydrogen. Now suppose I limit the action in this way: this piece of cotton-wool burns, as you see, very well in the atmosphere; and I have known of cases of cotton-mills being fired as if with gunpowder, through the very finely divided particles of cotton being diffused through the atmosphere in the mill, when it has sometimes happened that a flame has caught these raised particles, and it has run from one end of the mill to the other and blown it up. That, then, is on account of the affinity which the cotton has for the oxygen; but suppose I set fire to this piece of cotton which is rolled up tightly; it does not go on burning, because I have limited the supply of oxygen, and the inside is prevented from having access to the oxygen, just as it was in the case of the lead by the oxide. But here is some cotton which has been imbued with oxygen in a certain manner. I need not trouble you now with the way it is prepared; it is called gun-cotton. See how that burns [setting fire to a piece]; it is very different from the other, because the oxygen that must be present in its proper amount is put there beforehand. And I have here some pieces of paper which are prepared like the gun-cotton, and imbued with bodies containing oxygen. Here is some which has been soaked in nitrate of strontia—you will see the beautiful red color of its flame; and here is another which I think contains baryta, which gives that fine green light; and I have here some more which has been soaked in nitrate of copper,—it does not burn quite so brightly, but still very beautifully. In all these cases the combustion goes on independent of the oxygen of the atmosphere. And here we have some gunpowder put into a case, in order to show that it is capable of burning under water. You know that we put it into a gun, shutting off the atmosphere with shot, and yet the oxygen which it contains supplies the particles with that without which chemical action could not proceed. Now I have a vessel of water here, and am going to make the experiment of putting this fuse under the water, and you will see whether that water can extinguish it; here it is burning out of the water, and there it is burning under the water, and so it will continue until exhausted, and by reason of the requisite amount of oxygen being contained within the substance. It is by this kind of attraction of the different particles one to the other that we are enabled to trace the laws of chemical affinity, and the wonderful variety of the exertions of these laws.

Now I want you to observe that one great exertion of this power which is known as *chemical affinity* is to produce HEAT and light; you know as a matter of fact, no doubt, that when bodies burn they give out heat, but it is a curious thing that this heat does not continue—the heat goes away as soon as the action stops, and you see by that that it depends upon the action *during the time* it is going on. That is not so with gravitation; this force is continuous, and is just as effective in making that lead press on the table as it was when it first fell there. Nothing occurs there which disappears when the action of falling is over; the pressure is upon the table, and will remain there until the lead is removed; whereas, in the action of chemical affinity to give light and heat, they go away immediately the action is over. This lamp *seems* to evolve heat and light continuously, but it is owing to a constant stream of air coming into it on all sides, and this work of producing light and heat by chemical affinity will subside as soon as the stream of air is interrupted. What, then, is this curious condition of heat? Why it is the evolution of another power of matter, of a power new to us, and which we must now consider as if it were the very first time it was brought under our notice. What is heat? We recognise heat by its power of liquefying solid bodies and vaporizing liquid bodies, by its power of setting chemical affinity going and very often overcoming it. Then how do we obtain heat? We obtain it in various ways; most abundantly by means of the chemical affinity we have just before been speaking about, but we can also obtain it in many other ways. Friction will produce heat. The Indians rub pieces of wood together until they get them hot enough to take fire, and such things have been known as two branches of a tree rubbing together so hard as to set the tree on fire. I do not suppose I shall set these two pieces of wood on fire by friction; but I can readily produced heat enough to ignite some phosphorus. [The Lecturer here rubbed two pieces of cedar wood strongly against each other for a minute, and then placed on them a piece of phosphorus, which immediately took fire.] And if you take a smooth metal button stuck on a cork, and rub it on a piece of soft deal wood, you will make it so hot as to scorch wood and paper, and burn a match.

Fig. 5.

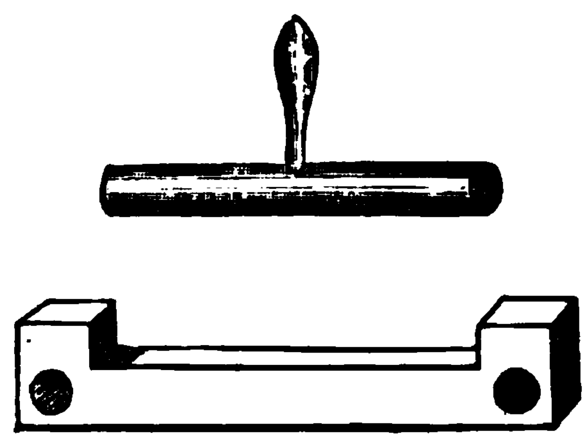


I am now going to show you that we can obtain heat not by chemical affinity alone, but by the pressure of air. Suppose I take a pellet of cotton and moisten it with a little ether, and put it into a glass tube (Fig. 5), and then take a piston and press it down suddenly, I expect I shall be able to burn a little of that ether in the vessel. It wants a suddenness of pressure or we shall not do what we require. [The piston was forcibly pressed down, when a flame due to the combustion of the ether was visible in the lower part of the syringe.] All we want is to get a little ether in vapor, and give fresh air each time, and so we may go on again and again getting heat enough by the compression of air to fire the vapor of ether.

This, then, I think, will be enough, accompanied with all you have previously seen, to show you how we procure heat. And now for the

effects of this power. We need not consider many of them on the present occasion, because when you have seen its power of changing ice into water and water into steam, you have seen the two principal results of the application of heat. I want you now to see how it expands all bodies—all bodies but one, and that under limited circumstances. Mr. Anderson will hold a lamp under that retort, and you will see the moment he does so that the air will issue abundantly from the neck which is under water, because the heat which he applies to the air causes it to expand. And here is a brass rod (Fig. 6) which goes through that hole and also fits accurately into this gauge; but if I make it warm with this spirit-lamp it will only go in the gauge or through the hole with difficulty; and if I were to put it into boiling water it would not go through at all. Again: as soon as the heat leaves bodies they collapse; see how the air is contracting in the vessel now Mr. Anderson has taken away his lamp; the stem of it is filling with water. And notice now that although I cannot get the tube through this hole or into the gauge, the moment I cool it by dipping it into water, it goes through with perfect facility, so that you see we have a perfect proof of this power of heat to contract and expand bodies.

Fig. 6.



(To be Continued.)

Specification of a Patent granted to FREDERICK AUGUSTUS ABEL *for Improvements in Protecting from Fire, Textile Materials in the Raw or in the Manufactured State.**—[Dated 23d December, 1859.]

The improvements forming the subject of this invention consist in affording protection against fire to textile materials in the raw or in the manufactured state, by impregnating such materials with insoluble metallic silicates within the fibre of the material.

The process by which this is effected is as follows:—Prepare a solution of lead, of zinc, or, practically speaking, of any other metallic base capable of forming, by its action upon a soluble silicate, a double silicate, insoluble in water, and, by preference, a basic acetate of lead, prepared, as is well known, by boiling sugar of lead and litharge with water. It has been found that solutions of various strengths will answer the purpose, yet the one preferred is prepared by boiling together twenty-five pounds of sugar of lead, fifteen pounds of litharge, and forty gallons of water, for about half an hour, and allowing the same to stand for about a couple of hours; the decanted clear solution forms a liquor well adapted to the purpose of the patentee.

To use the liquor so prepared, and which, in the present instance, is a solution of basic acetate of lead, the patentee takes such a quantity of it as will be at least sufficient to cover completely the fabric or material intended to be made uninflammable, or else the fabric or material may, in many cases, be simply passed through the liquid, raised to nearly the boiling point; the object being simply to saturate or im-

*From Newton's London Journal, August, 1860.

pregnate it thoroughly with the liquor. This having been done, the fabric so saturated with the liquor is to be removed, and spread out for about twelve hours to the contact of the air. This hanging out of the fabric or material to the air may be dispensed with, but it is preferred to do so, the subsequent operation now to be described yielding then a better result.

The fabric, after having been subjected to the first operation just described, should now be immersed for a period of from one to two hours, or thereabouts, in a hot and moderately strong solution of an alkaline silicate, by preference, in silicate of soda. It should then be withdrawn from the bath of alkaline silicate, allowed to drain, washed thoroughly in soft water, and dried; when it will be found to have acquired the properties claimed for it.

The patentee does not confine himself to the use of any particular silicate, or of any metallic salt, nor to the precise *modus operandi* described; but he claims, "protecting from fire textile materials in the raw or in the manufactured state, by the production of an insoluble silicate within the fibre or texture of the said textile materials.

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*On the means of Increasing the Angle of Binocular Instruments, in order to obtain a Stereoscopic Effect in proportion to their Magnifying Power.** By Mr. A. Claudet.

In a paper on the stereoscope, which Mr. Claudet read before the Society of Arts in the year 1852, alluding to the reduction of the stereoscopic effect produced by opera-glasses on account of their magnifying power, he stated that, in order to reduce that defect, it would be necessary to increase the angle of the two perspectives. This he proposed to do by adapting to the object-glasses two sets of reflecting prisms, which by the greater separation given to the two lines of perspectives, would reflect on the optic axes images taken at a greater angle than the angle of natural vision. Such was the instrument that Mr. Claudet submitted to the British Association, to prove, as he has always endeavored to demonstrate in various memoirs, that the binocular angle of stereoscopic pictures must be in proportion to the ultimate size of the pictures on the retina, larger than the natural angle when the images are magnified, and smaller when they are diminished; which, in fact, is nothing more than to give or restore to these images the natural angle at which the objects are seen when we approach them or recede from them. For magnifying or diminishing the size of objects is the same thing as approaching them or receding from them, and in these cases the angles of perspectives cannot be the same. Mr. Claudet showed that, looking at the various rows of persons composing the audience with the large ends of the opera-glass, all the various rows appeared too close to one another, that there was not between them the distance which separates them when we look with the eyes alone; and he showed also that, with the small end, the distance appeared considerably exaggerated. But, applying the sets of prisms to the opera-glass in order to increase the an-

* From the London Athenæum, July, 1860.

gle of the two perspectives, then looking at the audience as before, it appeared that the various rows of persons had between them the natural distance expected for the size of the image or for the reduction of the distance of the objects. By applying the two sets of prisms before the eyes without the opera-glass, it was observed, as was to be expected, that the stereoscopic effect was considerably exaggerated, because the binocular angle was increased without magnifying the objects. But looking with the two sets of prisms alone at distant objects, the exaggeration of perspective did not produce an unpleasant effect. It appeared as if we were looking at a small model of the objects brought near the observer. By the same reason, stereoscopic pictures of distant objects (avoiding to include in them near objects) can advantageously be taken at a larger angle than the natural angle, in order to give them the relief of which they are deprived as much when we look at them with the eyes, as when we look only with one eye; instead of being a defect, it seems that it is an improvement. In fact, the stereoscope gives us two eyes to see pictures of distant objects.—*Proc. Brit. Assoc.*, 1860.

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*On the Principles of the Solar Camera.** By A. Claudet.

The solar camera invented by Woodward, is one of the most important improvements introduced in the art of photography since its discovery. By its means, small negatives may produce pictures magnified to any extent; a portrait taken on a collodion plate not larger than a visiting-card, can be increased, in the greatest perfection, to the size of nature; views as small as those for the stereoscope can be also considerably enlarged. This is an immense advantage, which is easily understood when we consider how much quicker and in better proportion of perspective small pictures are taken by the camera obscura, while the manipulation is so greatly simplified. There is nothing new in the enlargement of photographic pictures. This has been done long ago simply by attending to the law of conjugate foci; and every photographer has always been enabled, with his common camera, to increase or reduce the size of any image. For the enlargement, it was only necessary to place the original very near the camera, and to increase in proportion the focal distance. But the more the focal distance was increased, the more the intensity of light was reduced; and a still greater loss of light arose from the necessity of diminishing the aperture of the lens, in order to avoid the spherical aberration. Such conditions rendered the operation so long that it became almost an impossibility to produce any satisfactory results when the picture was to be considerably enlarged. For these reasons, it naturally occurred that if the negative, having its shadows perfectly transparent and its lights quite black, was turned against the strong light of the sun, its positive image at the focus of the camera would be so intense that the time of exposure would be considerably reduced. So that, in order to employ the light of the sun, and follow easily its position without having to move constantly the whole camera, it was

* From the London Athenæum, July, 1860.

thought advisable to employ a movable reflecting mirror, sending the parallel rays of the sun on a vertical plano-convex lens condensing those rays on the negative, placed before the object glass and behind the condenser, somewhere in its luminous cone. Many contrivances for this object were resorted to, but without considering any thing else than throwing the strongest light possible on the negative to be copied. The constructors of these solar cameras never thought it very important to consider whether the focus of the condensing lens was better to fall before or behind the front of the object glass, provided the negative was placed in the luminous cone of the condenser. This want of attention has been the cause which has made the solar camera a very imperfect instrument for copying negatives. The beautiful principle of Woodward's apparatus consists in his having decided the question of the position of the focus of the condenser, and in having placed it exactly on the front lens of the camera obscura. As this principle had not yet been explained when the invention was exhibited before the Photographic Societies of London and Paris, and not even by the inventor himself in the specification of his patent, Mr. Claudet has undertaken, in the interest of the photographic art, to bring the subject before the British Association, and to demonstrate that the solar camera of Woodward has solved the most difficult problem of the optics of photography, and is capable of producing wonderful results. This problem consists in forming the image of the negative to be copied only by the centre of the object-glass reduced to the smallest aperture possible, without losing the least proportion of the light illuminating the negative. The solar camera does not require any diaphragm to reduce the aperture of the lens, because every one of the points of the negative are visible only when they are defined on the image of the sun, and they are so (in that position exclusively), for the centre of the lens is the only point which sees the sun, while the various points of the negative which form the marginal zone of the lens, are defined against the comparatively obscure parts of the sky surrounding the sun, are, as it were, invisible to that zone; so that the image is produced only by the central rays, and not in the least degree by any other points of the lens, which are subject to spherical aberration. It is, in fact, a lens reduced to an aperture as small as is the image of the sun upon its surface, without the necessity of any diaphragm, and admitting the whole light of the sun after it has been condensed upon the various separate points of the negative. It is evident that, from the centre of the lens the whole negative has for background the sun itself, and from the other points of the lens it has for background only the sky surrounding the sun, which fortunately has no effect in the formation of the image. Such is the essential principle of Woodward's solar camera, which did not exist in that instrument when the focus of the condenser was not on the object-glass. This principle is truly marvellous, but it must be observed that the solar camera, precisely on account of the excellence of this principle, requires the greatest precision in its construction. For its delicate performances, it must be as perfect as an astronomi-

cal instrument, which, in fact, it is. The reflecting mirror should be plane, and with parallel surfaces, in order to reflect on the condenser an image of the sun without deformation; and in order to keep the image always on the very centre of the object-glass, the only condition for the exclusion of the oblique rays, the mirror should be capable by its connexion with a heliostat of following the movements of the sun. The condenser itself should be achromatic, in order to refract the image of the sun without dispersion, and to define more correctly the lines of the negative; and a no less important condition for losing nothing of the photogenic rays would be, to have it formed with a glass perfectly homogeneous and colorless. With such improvements, the solar camera will become capable of producing results of the greatest beauty; and, without any question, its introduction into the photographer's studio will mark a period of considerable improvement in the art.—*Proc. Brit. Assoc.*, 1860.

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*On the Perception of Colors.** By Dr. Gladstone.

The author described himself as in an intermediate position between those who have a normal vision of colors, and those who are termed "color-blind." These latter are usually unacquainted with the sensations of either red or green, and it becomes a desideratum to have good observations on those who are capable of acting somewhat as interpreters between them and those who perceive every color. By means of Chevreul's chromatic circles and scales, Maxwell's color-top, colored beads, &c., the author was able to determine the following points in respect to his own vision. He sees red, in all probability, like other people, but it requires a larger quantity of the color to give the sensation than is usually the case; hence a purple appears to him more blue, and an orange more yellow, than to the generality of observers. He is perfectly sensible of green, or rather of two distinct greens,—the one yellowish, the other blueish,—but between them there lies a particular shade of green, to which his eyes are insensible as a color. This modifies his perception of many greens that approximate to what is to him invisible. The shade occurs in nature on the back of the leaf of the variegated holly, and it may be produced in Maxwell's top by certain combinations of the colored disc; the simplest being:—

94·5 Brunswick Green (Blue Shade) + 5·5 Ultramarine = 94 Black + 6 White.

While able perfectly to distinguish between red and green, the contrast does not readily catch his eye, especially at a distance; in fact, he is somewhat short-sighted in respect to these colors. He has reason to believe that, in his case, there has been a gradual improvement in his actual perception of colors, independently of his greater knowledge of them, though this is in opposition to the general experience of those whose vision is in any way abnormal, and no other instance was known to the late Prof. George Wilson, whose book is the standard one on the subject of color-blindness.

* From the London Athenæum, July, 1860.

*On the Use of Granite.** By Gardner Wilkinson.

As the question of using granite for building and monumental purposes has been much discussed, I beg to offer a few remarks connected with it, and to notice a fact which shows at how early a period the ancient Egyptians had watched the effect of atmospheric and other influences on stone, and how wisely they profited by the lessons taught them by experience. They had learnt that earth, abounding with nitre, from its attracting moisture, had the effect of decomposing granite, but that in the dry climate of Upper Egypt the stone remained for ages uninjured when raised above all contact with the ground. When, therefore, there was a possibility of its being exposed to damp, they based an obelisk, or other granite monument, on limestone substructions; and these last are found to the present day perfectly preserved, while the granite above them gives signs of decay in proportion to its contact with the earth subsequently accumulated about it. I am speaking of Upper Egypt, visited only four or five times in a year by a shower of rain; for in the Delta granite remains have been affected in a far greater degree than in the Thebaïd. Nitre abounds there, and it is remarkable that the obelisks at Alexandria have suffered least on the sides next the sea.

The Egyptians seldom used granite as a building stone, except for a small sanctuary in some sandstone temple; and in the later times of the Ptolemies one or two temples were built entirely of granite. But in the pure Egyptian period, that stone was chiefly confined to the external and internal casing of walls, to obelisks, doorways, monolithic shrines, sarcophagi, statues, small columns, and monuments of limited size, and was sometimes employed for roofing a chamber in a tomb.

The durability of granite varies according to its qualities. The felspar is the first of its component parts which decompose, and its greater or less aptitude for decay depends on the nature of the base of which the felspar consists. Egypt produces a great variety of granite, and the primitive ranges in the desert, east of the Nile, about 35 miles from the Red Sea, supplied the Romans, with numerous hitherto unknown kinds, as well as with porphyry, which they quarried so extensively in that district; but the granite of the ancient Egyptians came from the quarries of Syene, in the valley of the Nile, and from these they obtained what was used for their monuments. It is from this locality that the name of "Syenite" has been applied to a certain kind of granite; it is, however, far from being all of the same nature, and a small portion of the stone found there is really what we now call "Syenite."

Already, at the early period of the third and fourth dynasties, between twelve and thirteen centuries before the Christian era, the Egyptians extensively employed granite for various purposes. They had learnt to cut it with such skill that the joints of the blocks were fitted with the utmost precision. Deep grooves were formed in the hard stone with evident facility; and it must have been known to them for a long period before the erection of the oldest monuments that re-

* From the London Builder, No. 907.

main—the Pyramids of Memphis, where granite was introduced in a manner which could only result from long experience. Again, in the time of the first Osirtasen, about 2050 B.C., granite obelisks were erected at Heliopolis, and in the Fyoóm, and other granite monuments were raised in the same reign at Thebes; from which we find that even then the Egyptians had learnt how the damp earth acted on granite when buried beneath it; and this interesting question subsequently suggests itself—how long before that time must the stone have been used to enable them to obtain from experience that important hint which led them to place granite on limestone substructions?

I have already had occasion to offer some remarks on the mode of treating granite surfaces, which has been so ably detailed by Mr. Bell, at the meeting of the Society of Arts (March 14); and I have stated that the Egyptians adopted the broad character of ornamentation in sculpturing granite very judiciously advocated by him. I will, therefore, only add, that other good examples of such treatment may be found in early crosses of Cornwall, Devonshire, and other localities in this country; where what has been (rather hastily) called the Runic knot,—a design of entwined basket-work, common also in Italy, and other countries,—the large scroll pattern also frequently met with on the same monuments, and numerous massive ornaments in relieved intaglio, cut in the thickness of the stone are instances of a style of decorative sculpture admirably suited to granite.

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*Great Achievement of Mechanical Ingenuity.**

There is now to be seen at Bennett's, the well-known watch manufacturer of Cheapside, a gold hunting-watch of so remarkable a character as to well deserve description in our columns. In addition to being a time-keeper of the utmost precision, with chronometer adjustments, compensation balance, and cylindrical spring, it exhibits on the dial-plate the following different indications: first, the equation of time; secondly, the moon's age; thirdly, the month of the year; fourthly, the day of the month, in addition to the hours, minutes, and seconds, as in an ordinary watch. The mechanism is so contrived that any one or the whole of the hands may be set forwards or backwards at pleasure without deranging the rest. Mr. Bennett, the manufacturer of this remarkable production, naturally regards it as one of the highest triumphs of modern horological science; for these extraordinary time-keepers have hitherto been considered rather as mechanical marvels than as of practical use. In this case every movement is laid down in the strictest proportion, and based upon calculations of an absolutely scientific character. Although it has taken more than a twelve-month in its production, and is inclosed in a handsome gold case, it is within the compass of a pocket time-keeper. We strongly recommend those of our readers interested in mechanical science, to avail themselves of the opportunity of gratifying their curiosity as to what is possible to be effected by the enterprise of one of our leading watch manufacturers.

* From the Lond. Mechanics' Mag., June, 1860.

*On a New Form of Chloride of Sodium.** By RICHARD V. TUSON, Lecturer on Chemistry at Charing Cross Hospital.

That chloride of potassium, which ordinarily crystallizes in cubes is nevertheless often found as an efflorescence on various vegetable extracts assuming the acicular form is well known.

Hitherto, I believe, the corresponding compound, chloride of sodium, has never been observed in needle-shaped crystals but nearly always in cubes.

Occasionally, however, it deposits from urine in octahedra, and when a solution of the salt in water is evaporated at a temperature not exceeding 14° F. it crystallizes in hexagonal tables (Ehrenberg) which contain, according to Fuchs, six equivalents, but, according to Mitscherlich, four equivalents of water of crystallization. At temperatures above 14° F. these hexagonal crystals lose their water of crystallization and are resolved into a congeries of minute cubes. Chloride of sodium, it is also stated, may be obtained in large oblique rhombic prisms having the formula $NaCl + 4Ag$. They effloresce in air below 32° F. (Mitscherlich), deliquesce (? effloresce) in air above 32° F. (Fuchs), and leave a powder of small tubes.

Lately on opening a tightly-fitting tin box, in which a quantity of salmon-roe paste had been allowed to remain for nearly three years, it was found that the organic matter was covered by an efflorescence of acicular crystals. One of my pupils collected some of these crystals, analyzed them, and pronounced them to consist entirely of chloride of sodium. As I had never heard of chloride of sodium crystallizing in needles, their examination was repeated, but still the same results were obtained. Some of the crystals were next dissolved in water, and the solution produced submitted to spontaneous evaporation, when the whole of the salt deposited in the ordinary or cubical form. This result, therefore, fully confirms the conclusions deduced from analysis.

The crystals, some of which are nearly half an inch long, appear to be rectangular prisms terminated by four-sided pyramids. They are beautifully clear, colorless, transparent, elastic, longitudinally and transversely striated, and many are bent or contorted in a manner similar to the native hydrated sulphate of lime called selenite by mineralogists.

The acicular crystals are anhydrous and undergo no change in form or diminution in transparency when exposed to air at ordinary temperatures, or even at a low red heat. The needles of chloride of sodium possess one property which is a very familiar characteristic of the cubical salt, namely, that when heated they decrepitate. It is singular to remark, that, at all events as far as we know at present, the acicular varieties of the chlorides of potassium and of sodium are only developed in the presence of organic matter, just as the production of octahedral chloride of sodium appears to be due to the solution from which it crystallizes containing urea.

Since writing the foregoing, I have observed an efflorescence of

* From the Lond. Chemical News, No. 34.

acicular chloride of sodium on an animal deposit which was sent me for analysis, and which had been originally mixed with a solution of common salt to prevent it undergoing putrefaction.

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*A New Kind of Bath.**

M. Mathieu (de la Drôme) one of the most eminent orators of the "Mountain" in the National Assemblies of 1848 and 1849, has lately been turning his attention to the subject of medicinal baths. A bath by immersion requires from two to three hectolitres of water, which, in the case of mere river or spring water, is of no consequence as regards expense. But the case is far different when the water is to be impregnated with medicinal substances, some of which are very costly; or when mineral waters are prescribed, which cannot be had in large quantities without considerable outlay, except at the spring from which they are derived. M. Mathieu (de la Drôme) has therefore endeavored to ascertain, both by calculation and experiment, what is the real quantity of water which produces a useful effect on a human body in a common bath, and has found that it cannot be more than three or four litres in the course of an hour. To distribute this quantity both equally and economically on the body was, therefore, the question to be solved; and he has accordingly invented an apparatus, which he calls *bain hydrofère*. The patient is seated in a kind of box like that used for fumigation, while a powerful ventilator outside transforms the water which is to be used into a minute aqueous dust or dew, just as we see a high wind do with the water issuing from the jets of a monumental fountain. This dew is driven into the box through an aperture on a level with the knees; owing to the extreme minuteness of its particles, the latter ascend, and then gradually subside on the body. In a short time these particles coalesce and trickle down the body, until at last the water descends in an unceasing stream. This system has now been tried with great success at the Hôpital St. Louis, and is now generally attracting the attention of medical men.

*From the London Engineer, No. 232.

The Specific Gravity of Mixtures of Alcohol and Water.†

After three series of determinations which have occupied him more than a year, H. von Baumhauer has arrived at the conviction that the specific gravities of mixtures of alcohol and water, as determined by Gilpin, Löwitz, and Gay-Lussac, are very incorrect. In the first series of experiments the mixtures were made by volume, but as these gave results so different from those generally received, the author repeated his experiments with mixtures made by weight as well as by measure. These, however, only confirmed the results previously obtained. The author started with absolute alcohol having a sp. gr. of 0·7946 at 59° F. In the second series, alcohol from another source was used, which had the sp. gr. 0·7947 at the same temperature. The water used in the experiments was distilled and carefully deprived of

† From the Lond. Chemical News, No. 18.

air. After corrections for slight mistakes, the results obtained were as follows:—

Alcohol in 100 of the mixture.	1st Series.	2d Series.
100	0·7939	0·7940
95	0·8119	0·8121
90	0·8283	0·8283
85	0·8438	0·8432
80	0·8576	0·8572
75	0·8708	0·8708
70	0·8837	0·8938
65	0·8959	0·8963
60	0·9079	0·9081
55	0·9193	0·9196
50	0·9301	0·9302
45	0·9394	0·9400
40	0·9485	0·9491
35	0·9567	0·9569
30	0·9635	0·9636
25	0·9692	0·9696
20	0·9746	0·9747
15	0·9799	0·9800
10	0·9855	0·9855
5	0·9919	0·9918
0	0·9991	0·9991

*The Green Coloring Matter of Leaves.**

M. Frémy has also studied the constitution and composition of chlorophyll, which he supposes to be made up of two coloring matters, a blue and yellow, the first of which he names *phyllocyanine*, and the second *phylloxanthine*. M. Frémy discovered that by the action of some bases the green matter of leaves is changed to a beautiful yellow substance, which is easily dissolved by alcohol. In this solution, hydrochloric and some other acids will immediately restore the primitive green color. To separate the blue and yellow matters, M. Frémy proceeded as follows:—He first placed in a stoppered bottle two parts of ether and one part of hydrochloric acid, diluted with a little water, and then shook the bottle strongly for some time. He then submitted to the action of this liquid the body produced by the decolorization of the chlorophyll, shaking them together for some seconds. The effect was very remarkable. The ether dissolved the yellow matter of the leaves and became of a beautiful yellow color, while the hydrochloric acid reacted upon the green matter which had been decolorized, and produced a magnificent blue. The two colors are thus isolated, and, being retained by two different liquids, cannot be mixed to reproduce the green; but if the liquids are separated and the coloring matters withdrawn from them, solution in alcohol, which dissolves both, gives immediately a green tint comparable to that of the original chlorophyll. M. Frémy entertains some reasonable doubts whether his phyllocyanine and phylloxanthine really exist in vegetables,

* From the London Chemical News, No. 19.

and proposes to continue and extend his investigations on the subject. The whole subject is very interesting, and deserves a longer notice than we can give in this correspondence.

*Vegetable Coloring Matters.**

M. Filhol has been engaged in the examination of vegetable coloring matters, and has discovered some facts which he now publishes as briefly as possible, intending to give all the details in a longer memoir. There exists in nearly all flowers, says M. Filhol, a substance which is scarcely colored when in solution in acid liquids, but which becomes of a beautiful yellow color when acted on by alkalies. This substance has the following properties. It is solid and of a slightly greenish-yellow color. It is uncrystallizable, soluble in water, alcohol, and ether, and not volatile. When moistened with strong hydrochloric acid, it takes a bright yellow tint which immediately disappears when the mixture is diluted with water, leaving an almost colorless solution to which alkalies communicate a yellow color. The matter is found in the green parts of plants as well as the flowers, and is, no doubt, the yellow dye found in the leaves of various plants. M. Filhol adopts the name given to it by Hope, and calls it *Xanthogene.* Mosses, he says, do not contain it, or, at most, only a trace. It is also absent from some flowers, among others the *Pelargonium Zonale*, and *inquinans Papaver rheas*, Camellias and Salvias. These flowers under the influence of alkalies become blue or violet without the least mixture of green. The coloring matter of these flowers is much less alterable under the influence of air and alkalies than that of most other flowers.

Chemists who have examined yellow flowers, have proved that they owe their color to several immediate principles; among others, *xanthine* and *xantheine.* The author has discovered *xanthine* in fruits as well as flowers.

* From the Lond. Chemical News, No. 19.

On the Density of Saturated Steam, and on the Law of Expansion for Superheated Steam.† By William Fairbairn, F. R. S.

At the last meeting of the British Association, I detailed a new method of ascertaining the specific gravity of vapors, which, in conjunction with my friend Mr. Tate, I was employing with a view to ascertain the density of steam at all temperatures. It may be of interest to the Association to know, that I believe the method to have proved itself reliable, and that we have now experimental determinations of the density of steam; and these fully verify the anticipations of Mr. Thomson and Mr. Rankine, that the vapor of water does not accurately obey the gaseous laws. We have found the density of saturated steam always greater than that given by the gaseous steam, even for temperatures as low as 136° Fah., and for pressures less than that of the atmosphere.

† From the Lond. Civ. Eng. and Arch. Journal, Aug., 1860.

The experiments as they stand at present extend over a range of temperature from 136° to 292° Fah., or from 2·6 to 60 lbs. pressure per square inch. But as we hope to extend them to higher pressures, I have preferred to leave at present the consideration of their bearing on other formulæ, and the ultimate generalizations to which they may lead in regard to the use of steam. The following simple formula, however, very nearly expresses the results of the experiments as to the density and pressure of saturated steam, the relation between pressure and temperature having been already determined with scrupulous accuracy by the elaborate investigations of Regnault.

Let V be the specific volume of the steam, or volume as compared with that of an equal weight of water; P = the pressure in inches of mercury. Then I find

$$V = 25{\cdot}62 + \frac{49513}{P + {\cdot}72}.$$

Table of Results, showing the Relation of Density and Pressure of Saturated Steam.

No.	Pressure. In lbs. per square inch.	Pressure. In inches of mercury.	Temperature, Fahrenheit.	Specific volume. From experiment.	Specific volume. By formula.	Proportional error of formula.
1	2·6	5·35	136·77	8266	8183	+ 1-100
2	4·3	8·62	155 33	5326	5326	0
3	4·7	9·45	159·36	4914	4900	— 1-350
4	6·2	12·47	170·92	3717	3766	+ 1-74
5	6·3	12·61	171·48	3710	3740	+ 1-123
6	6·8	13·62	174 92	3433	3478	+ 1-76
7	8·0	16 01	182 30	3046	2985	— 1-50
8	9·1	18·36	188·30	2620	2620	0
9	11·3	22 88	198·78	2146	2124	— 1-97
1	26·5	53 61	242·90	941	937	— 1-235
2	27 4	55·52	244 82	906	906	0
3	27·6	55·89	245·22	891	900	+ 1-100
4	33·1	66·84	255·50	758	758	0
5	37·8	76·20	263·14	648	669	+ 1-32
6	40·3	81·53	267·21	634	628	— 1-100
7	41·7	84·20	269·20	604	608	+ 1-150
8	45·7	92·23	274·76	583	562	— 1-29
9	49·4	99·60	279·42	514	519	+ 1-100
11	51·7	104·54	282·58	496	496	0
12	55·9	112·78	287·25	457	461	+ 1-114
13	60 6	122·25	292 53	432	428	— 1-108
14	56·7	114·25	288 25	448	456	+ 1-56

The above table exhibits accurately the results at which we have arrived in regard to saturated steam; we have also obtained some results on the rate of expansion of superheated steam. These results are at present less complete than those upon saturated steam, as they do not range more than 20 degrees of temperature in each case above the maximum temperature of saturation. They appear, however, to show conclusively, that near the saturation point steam expands very

irrregularly, thus agreeing with what we know of other bodies in their physical relations at or near the point at which they change their state of aggregation. Close to the saturation point we find a very high rate of expansion, but this rapidly declines as the steam superheats, and at no great distance above it the rate of expansion nearly approximates to that of a perfect gas.

Thus, for instance, in Experiment 6, where the point of maximum saturation was 174·92, between this and 180° the steam expanded at the rate of $\frac{1}{190}$, whereas air would have expanded $\frac{1}{834}$; but on continuing the superheating, the co-efficient was reduced between 180° and 200° from $\frac{1}{190}$ to $\frac{1}{837}$, and for air the co-efficient would have been $\frac{1}{839}$, or almost exactly the same: and this rule holds good in every experiment; a high rate of expansion close to the saturation point diminishing rapidly to an approximation to that of air.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JULY 1, TO JULY 31, 1860.

Air or Gases,—Exhausting	R. W. Sievier,	U. Holloway,	Engl'd,	17
Anchors,—Appa's for Working	Angus Campbell,	Jersey City,	N. J.	3
Aniline Colors,—Preparation of	Joseph Renard,	Lyons,	France,	31
Awning Fixtures,	Edward Peach,	Utica,	N. Y.	31
Axe Helves,—Metal Cap for	A. W. Porter	St. Johnsville,	Vt.	17
Axles,—Car	Wm. Phelps,	Sycamore,	Ill.	3
Axletrees,—Setting	Arvin & Perkins,	Valparaiso,	Ind.	17
Bandages,—Catamenial	Dahis & Doermer,	Brooklyn,	N. Y.	31
Battery,—Chain Shot	C. B. Thayer,	Boston,	Mass.	24
Bed and Chair,—Combined	G. A. Keene,	Lynn,	"	3
Bed Cord,	Stephen Albro,	Buffalo,	N. Y.	3
Bedstead,—Secretary	George Gage,	Kendall's Mills,	Me.	24
Bee-hives,	Nathan Brasher,	Green Fork,	Ind.	31
———	Matthias M'Gonnigle,	Alleghany,	Penna.	31
Belt Lacing	H. A. Alden,	Matteawan,	N. Y.	31
Bench Hook,	Russel Frisbie,	Middletown,	Conn.	10
Bending Wood,—Machine for	Seidle & Eberly,	Mechanicsburg,	Penna.	10
Blind Slat Machine,	Johnson & Doyle,	Wetumpka,	Ala.	31
Boat-lowering Apparatus,	Flowers & Patton,	Bangor,	Me.	24
Bone Black,—Washing	Chas. Kinzler,	City of	N. Y.	10
Boots and Shoes,	N. C. Lewis, Jr.,	Boston,	Mass.	24
—————,—Heel for	D. E. Somes,	Biddeford,	Me.	24
Bowls,—Making Wooden	Simonds & Goodspeed,	Ludlow,	Vt.	31
Brake,—Horse-power	Harvey & Becker,	Amsterdam,	N. Y.	24
Brake,—Self-acting Sleigh	Jacob Dutcher,	Gibson,	Penna.	24
Brake,—Wagon,	J. H. H. Bennett,	Hunt's Hollow,	N. Y.	24
—————	H. W. Norville,	Livingston,	Ala.	24
Brakes,—Railroad	C. F. Langford,	Fall River,	Mass.	3
Bread,—Manufacture of	Benjamin Garvey,	City of	N. Y.	17
Brick Machines,	I. M. Gattman,	Cincinnati,	Ohio,	3
—————	James Hotchkiss,	Yellow Springs,	"	17
Bridle Bits,	W. F. and W. R. Johnson,	Wetumpka,	Ala.	24
Broom,	Langdon & Weitman,	Hazleton,	Iowa,	17
——— or Brush,	J. H. Power,	Middletown,	"	10
Buckles,	S. S. Hartshorn,	New Haven,	Conn.	24
———	John Tiebout,	Brooklyn,	N. Y.	24

Burglar Alarm, .	A. H. Enholm, .	St. Louis,	Mo.	3
Butter Worker, .	C. A. Boynton, .	Hyde Park,	Vt.	17
Cables.—Surge-reliever for	James Bingham, .	Philadelphia,	Penna.	24
Calendar,—Pocket .	H. C. Foote, .	McGaheysville,	Va.	17
Candles,—Apparatus for Mould'g	G. A. Stanley, .	Cleveland,	Ohio,	31
Candlestick, .	H. E. Rogers, .	S. Manchester,	Conn.	24
Car Bodies with Trucks,	C. S. Moore, .	Alexandria,	Va.	3
Carpet-sweeper, .	Daniel Hess, .	West Union,	Iowa,	10
Carriage Body, .	Ernst Kirsch, .	New Haven,	Conn.	31
——— Tops,—Movable	J. S. Belcher, .	Albany,	N. Y.	10
Cartridge Case, .	J P. Lindsay, .	City of	"	24
Cartridges, .	B. B. Hotchkiss,	Sharon,	Conn.	10
———,—Packing	Christian Sharps, .	Philadelphia,	Penna.	10
Casting,—Moulds for .	S. A. Corser, .	Northampton,	Mass.	10
Center-board Vessels,—Constr'n	Ketchum & Hunt, .	Port Jefferson,	N. Y.	10
——— for Vessels,	Daniel G. Gerard,	Patchogue,	"	3
Chimney Cap, .	T. J. Fitzpatrick, .	New Orleans,	La.	24
Chimneys, .	B. W. Taber, .	Quaker Street,	N. Y.	24
Churn, .	Levi Bissell, .	N. Bergen,	"	10
——— .	N. B. Cooper, .	Gratis,	Ohio,	3
——— .	John Raff, .	Eden,	N. Y.	17
——— .	John Park, .	Joliet,	Ill.	31
——— .	Sherman & Fenwick,	Union Town,	Md.	31
Clap-boarding Gage, .	H. D. Vandercook,	Marshall,	Mich.	17
Clothes-frame, .	C. A. Boynton, .	Hyde Park,	Vt.	3
——— .	C. J. Ferguson, .	City of	N. Y.	17
——— .	Asa Greenwood, .	Toulon,	Ill.	17
——— .	Wm. Hathaway,	Providence,	R. I.	3
Clocks,—Pendulum	G. M. Phelps, .	Troy,	N. Y.	10
Cocks, .	Barton Pickering,	Dayton,	Ohio,	24
Coffee Pots, .	John Denley, .	Warsaw,	Ill.	24
——— .	George Neilson,	Boston,	Mass.	24
Condensing Apparatus,	G. S. G. Spence, .	"	"	31
Condensers, .	A. C. Brown, .	Philadelphia,	Penna.	10
Copper Vessels,—Planishing	H. Kay & T. Avery, Jr.,	Brooklyn,	N. Y.	17
Corn Planters, .	Samuel Avery, .	Pisgah,	Mo.	10
——— .	F. A. Goddard, .	Lexington,	Ill.	31
——— .	John Price, .	Harrison,	Ohio,	10
——— .	Christopher Smith, .	Nauvoo,	Ill.	31
—— Shellers, .	T. J. Newland, .	Wolcott,	Vt.	17
—— Stalks,—Shocking	S. B Lawrence, .	Hookstown,	Penna.	24
Cotton Bale Fastenings, .	T. McIntire, .	Franklin Furn.	Ohio,	17
——— Ties,	Z. W. and E. D. Lee,	Blakely,	Ga.	3
——— Pickers, .	John Griffin, .	Louisville,	Ky.	3
——— .	Lewis Jennings, .	Brooklyn,	N. Y.	31
——— Seed Hullers, .	P. Martin, .	New Orleans,	La.	31
——— Planters,	Zina Doolittle, .	Perry,	Ga.	10
Couplings,—Car .	J. P. Mendenhall,	Farmington,	Ill.	31
——— .	I. W. Van Houten, .	Philadelphia,	Penna.	3
——— for City R. R. Cars,	Collyer & Patterson,	"	"	17
——— R. R. Cars,	Otis Hood, Jr., .	Turner,	Me.	17
———	Thorp & Shurtleff,	"	"	17
——— of Thills for Axles,	John McDermott, .	Washington,	D. C.	24
———	Robert Morrison,	Rahway,	N. J.	24
———	James Sadler, .	Egremont,	Mass.	24
Cracker Machine, .	Cyrus Marsh, 2d,	Natchez,	Miss.	24
Cranes, .	J. T. Smith, .	Portsmouth,	Va.	10
Cultivators, .	Agnew & Morrison,	Chadd's Ford,	Penna.	10
——— .	Ephraim Briggs, .	Medina,	Ohio,	17
——— .	Council Clark, .	Andersonville,	Ga.	3
——— .	Ezra Emmert, .	Franklin Grove,	Ill.	31
——— .	Z. W. and E. D. Lee,	Blakely,	Ga.	31

Cultivators, .	J. B. Livezey, .	Clarksboro',	N. H.	10
———— .	Lostutter & Wolcott,	Rising Sun,	Ind.	31
———— .	Harrison Oghorn, .	Greenfork,	"	10
————,—Cotton .	T. H. Dodge, .	Washington,	D. C.	17
————————	Richard J. Gatling, .	Indianapolis,	Ind.	3
———————— .	J. A. Hartsfield,	Kinston,	N. C.	17
————————	Hinman & French, .	Watertown,	Mass.	10
———————— .	Rigell & Ivey, .	Dawson,	Ga.	17
———————— .	Jesse Speer, .	Hazlehurst,	Mass.	31
———————— .	G. W. N. Yost, .	Yellow Springs,	Ohio,	17
Curtain Fixture, .	Wm. Cleveland, .	City of	N. Y.	24
Cylinders,—Turning .	Gideon Sibley, .	Troy,	"	3
Distilling,—Appa's for boiling &	Wm. Hoffmire, .	San Francisco,	Cal.	31
———— Sea-water,—Appa's for	G. S. G. Spencer,	Boston,	Mass.	3
Ditching Machine,—Mole	Josiah Hodgson, .	N. Michigan,	Ill.	24
Door Plate,—Index .	Nathan Ames, .	Saugus Center,	Mass.	31
Dough,—Rollers for Pressing	Rice & Hayward, .	Providence,	R. I.	3
Dovetailing Machines,—Cutters	John Bell, .	Harlem,	N. Y.	10
Drain Tiles, .	E. W. Rowe, .	Brewer,	Me.	3
Dredging Apparatus, .	T. A Bryan, .	Queenstown,	Md.	6
Drills,—Ratchet .	L. R. Billard, .	Norfolk,	Va.	31
———,—Rock .	Cushman & French,	N. Bloomfield,	Cal.	3
Drilling Machines,—Rock	Francis Schwalm, .	Joliet,	Ill.	3
Engraving Copper Cylinders,	B. L. Philips, .	Providence,	R. I.	3
Excavating Machines,	G. S. Manning, .	Springfield,	Ill.	17
———— & Grading Machine,	P. T. Mayne, .	Keosauqua,	Iowa,	17
Fan Blowers, .	Henry Sweetapple, .	Napa,	Cal.	31
Fares,—Machine for Registering	M. W. Helton, .	Bloomington,	Ind.	24
Fats,—Machines for Cutting	W. E. Boulger, .	Janesville,	Wis.	3
———,—Appa's for Rendering	Tompert & Coyle,	Louisville,	Ky.	3
Faucets, .	James Flattery, .	Brooklyn,	N. Y.	24
Felly Machine, .	F. W. Mallett, .	New Haven,	Conn.	17
Fence Posts,—Socket for	Blood & Miller, .	Newport,	N. H.	3
——— Rails,— .	Christian Yost, .	Intercourse,	Penna.	3
Fences,—Portable .	W. M. Wallace, .	Cameron,	Ill.	3
Files,—Machines for Cutting	Etienne Bernot, .	Paris,	France,	24
————————	J. C. Cook, .	Middletown,	Conn.	10
Filters, .	John Fitch, .	Seneca Falls,	N. Y.	10
Fire,—Protecting Buildings	S. M. Andrus, .	Bellevue,	Mich.	10
Fire Arms,—Breech-loading	M. J. Gallager, .	Savannah,	Ga.	17
————————	R. F. Cook, .	Potsdam,	N. Y.	24
————,—Revolving	Ethan Allen, .	Worcester,	Mass.	3
————————	C. R. Alsop, .	Middletown,	Conn.	17
————————	A. J. Gibson, .	Worcester,	Mass.	10
Fire-place and Chimney,	Daniel Hemingway, .	Covington,	Ky.	17
Fire Pokers, .	G. R Moore, .	Pittsburgh,	Penna.	24
Flour Chest, .	I. R. Shank, .	Buffalo,	Va.	24
Flower Stands, .	H. J. Coster, .	Chicago,	Ill.	17
Fluting Apparatus, .	G. B. Arnold & others,	City of	N. Y.	24
Fly Trap, .	H. H. Robertson,	Kingston,	Mo.	3
Food,—Preserving .	W. A. Keeler, .	City of	N. Y.	31
Foot-cleaner, .	Shaler & Rogers,	Madison,	Conn.	31
Fruit-drying Apparatuses,	A. C. Lewis, .	Burlington,	Mich.	31
Friction Wires,—Making	D. J. Ferry, .	Philadelphia,	Penna.	24
Furnaces,—Air .	Keller & Young, .	Cincinnati,	Ohio,	17
————,—Hot-air	Ernst & Shepard,	Milwaukie,	Wis.	17
Garments,—Fastening for	C. W. Baldwin, .	Boston,	Mass.	3
Gas,—Apparatus for Generating	Alexander Schwaninger,	Milwaukie,	Wis.	24
—— Generators, .	C. N. Tyler, .	Washington,	D. C.	24
—— Meters, .	John Schatt, .	Philadelphia,	Penna.	24

Gas Pipes, .	Wm. Stephenson, .	Galion,	Ohio,	10
—— and Water Pipe Joint,	C. W. Isbell, .	New Haven,	Conn.	24
—— Regulators, .	Thos. & Chas. Champion,	Washington,	D. C.	24
———— for R. R. Cars,	A. H. Phillippi, .	Reading,	Penna.	31
—— Tubes,—Flexible Joints	Anthony Stratton, .	Brooklyn,	N. Y.	10
Gates, .	G. E. Baker, .	Waukegan,	Ill.	24
Gear of Vehicles, .	Richard Murdoch, .	Baltimore,	Md.	10
Glass,—Manufacture of	Horace Trumbull,	Jersey City,	N. J.	3
—— Furnaces, .	J. B. Hay, .	Winslow,	"	24
—— Goblets,—Moulds for	A. J. Sweeney, .	Wheeling,	Va.	3
Globes, .	James Monteith, .	City of	N. Y.	24
——,—School, .	J. R. Agnew, .	Philadelphia,	Penna.	24
————,—Suspending	James Monteith, .	City of	N. Y.	24
Grain Binders, .	J. S. Hickey, .	Pike,	Ill.	17
———— .	Thomas Courser, .	Princeton,	"	10
—— Cradles, .	E. D. Wilcox, .	Billingham,	Mass.	24
—— Separators, .	George Arrowsmith, .	Lockport,	N. Y.	10
————	Cornelius Bergen,	Farmer,	"	31
———— .	Thomas Earhart, .	Donelson,	Tenn.	24
————	John C. Gregg, .	Hillsboro',	Ohio,	17
———— .	A. J. Vandergrift, .	St. Louis,	Mo.	24
————,—Governor	L. D. Lane, .	Freeport,	Ill.	17
——,—Scouring & Separat'g	Matthew Bartholomew,	Enterprise,	Penna.	24
——,—Threshing & Cleaning	Ira Hart, .	Clarksburg,	Va.	31
—— Winnowing Machines,	Bean & Wright,	Hudson,	Mich.	24
Grate,—Furnace .	C. F. Cory, .	Lebanon,	Ill.	24
Grates,—Stove .	D. H. Nation, .	Albany,	N. Y.	24
——,—— and Furnace	John V. B. Carter,	"	"	24
Gridiron, .	Brooks & Grover, .	Rochester,	"	24
Grindstones,—Center for Shaft	David Hinman, .	Berea,	Ohio,	31
Handle to Picks, &c., .	J. H Fisher, .	Placerville,	Cal.	17
Harmoneons, .	H. W. Smith, .	Boston,	Mass.	3
Harness Buckle, .	J. W. Covel, .	Bangor,	Me.	31
Harrows, .	L. C. Gillespie, .	Denmark,	Tenn.	10
Harvesters, .	C. B. Brinckerhoff, .	Batavia,	N. Y.	10
—— .	B. A. Jenkins, .	Whitewater,	Wis.	10
—— of corn & sugar-cane,	G. W. N. Yost, .	Cincinnati,	Ohio,	10
Harvesting Machines,	J. N. Bowman,	Brockport,	N. Y.	10
———— .	J. H. Rible, .	Somerset,	Ohio,	10
————	Wm. Wilmington,	Toledo,	"	3
Hat Bodies,—Forming .	Platt & Wildman, .	Danbury,	Conn.	31
—— Ventilators, .	F. H. Bell, .	Washington,	D. C.	10
Hay Racks for Carts, .	H. R. Hawkins, .	Akron,	Ohio,	10
——,—Teeth for Scattering	J. C. Stoddard, .	Worcester,	Mass.	24
Hemp Brakes, .	E. W. Lacy, .	Oak Park,	Va.	31
Hides,—Preparing	A. D. Lufkin, .	Cleveland,	Ohio,	31
Hinges,—Spring .	Abram Acker, .	Ramapo,	N. Y.	17
Hoisting Apparatuses,	John Lemman, .	Cincinnati,	Ohio,	17
Hominy Machines, .	John Gehr, .	Clear Spring,	Md.	17
Hook,—Mousing .	Hjalmar Wynblad,	W. Hoboken,	N. J.	3
Horse Collars, .	C. J. Fisher, .	Wawkou,	Iowa,	17
Horse-shoe Machine,	Joseph Desnos, .	Troy,	N. Y.	31
Horses,—Shoeing .	G. R. Stevens, .	Clarksville,	Mo.	3
Horse-shoes,—Making	H. A. Wills, .	Keeseville,	N. Y.	3
Horse-stalls,—Attachment of	D. S. Neal, .	Lynn,	Mass.	24
Horses from Cribbing,	Bishop & Low, .	Warren,	"	31
———— Fire,—Rescuing	Elisha French, .	Braintree,	"	31
———— Vehicles,—Detach'g	A. B. Johnson & others,	Clarksville,	Mo.	3
————————	J. M. Roberds, .	Plaisance,	La.	24
Hot Water Apparatuses,	Henry Humphreyville, Jr.,	Strasburg,	Penna.	24
Ice-breaker, .	C. W. Chapman, .	Hartford,	Conn.	3
Ice-pick, .	J. T. Van Kirk, .	Philadelphia,	Penna.	17

Lamps,	James Adair,	Pittsburgh,	Penna.	31
———	Wm. Fulton,	Cranberry,	N. J.	24
———	Sumner Sargent,	Watertown,	Mass.	24
———	John Schley,	Savannah,	Ga.	24
———	I. W. Taber,	New Bedford,	Mass.	17
———	J. T. Van Kirk,	Philadelphia,	Penna.	17
——— for Locomotives,	James Radley,	City of	N. Y.	31
———,—Mica Chimney for	J. Y. Humphreys,	Philadelphia,	Penna.	17
———,—Vapor	Erastus Crooker,	Buffalo,	N. Y.	10
—————	I. Van Bunschoten	City of	"	31
Lathe,	Milton Roberts,	Worcester,	Mass.	10
Lath Machine,	R. J. Gatling,	Indianapolis,	Ind.	10
Leather,—Machs. for Crimping	Horace Wing,	Buffalo,	N. Y.	31
———,—Skiving	W. S. Williams,	Lynn,	Mass.	31
Lemon-squeezer,	L. S. Chichester,	City of	N. Y.	3
Lightning-rods,—Construction	J. M. Patterson,	Woodbury,	N. J.	31
Lights for Ships,—Side	Enoch Hidden,	City of	N. Y.	10
———,—Street	J. H. Kalb,	Charleston,	S. C.	31
Lock,	C. E. Brown,	Bridgeport,	Conn.	10
Locks,—Door	Calvin Adams,	Pittsburgh,	Penna.	3
Locomotive Engines,—Exhaust	John Dykeman,	Greenbush,	N. Y.	3
Looms,	L. R. Wattles,	Newton,	Mass.	31
———,—Pattern Chain for	B. H. Jenks,	Philadelphia,	Penna.	24
Lubricating Compound,	Radspinner & Moss,	N. Richmond,	Ohio,	3
——— Pistons,	Benjamin Garvey,	City of	N. Y.	17
——— Purposes,—Compo.	C. Chitterling,	Dunkirk,	"	24
Mattress and Bed,	F. Elder,	Winnsboro',	S. C.	10
Meat-cutter,	Louis Bonnet,	City of	N. Y.	24
———	J. G. Perry,	S. Kingston,	R. I.	31
Meat-cutters,—Cylinders for	S. R. Plumb,	Southington,	Conn.	31
Melodeons,	S. H. Jones,	Jamaica Plains,	Mass.	3
———	C. J. Van Oeckelen,	City of	N. Y.	3
Mills,	Wm. Joslin,	Cleveland,	Ohio,	3
———	A. H. Wagner,	Staunton,	Va.	31
Mill Bushes,	J. G. Shafer,	Fulton co.,	Penna.	3
Mills,—Corn and Cob	S. A. Briggs,	Philadelphia,	"	3
Millstones,—Dressing	M. H. Bacon,	Mystic,	Conn.	10
———	"	"	"	31
———	G. Z. Hockenburry,	Pittsburgh,	Penna.	24
———	Martin Shirk,	Lancaster co.,	"	24
Mills,—Grinding	Ruof, Heupel, & Leuthy,	"	"	3
Mop Head,	James Doty, Jr.,	West Falls,	N. Y.	17
Mortising Machine,	Eleazar Coffin,	Indianapolis,	Ind.	17
Motion to Machinery,—Transf.	Wm. Phelps,	Sycamore,	Ill.	3
Motive Power,	Towsley & Matteson,	City of	N. Y.	24
———,—Obtaining	Jacob Pringle,	Summer Hill,	Penna.	24
———,—Steam for	J. W. Durham,	Durhamville,	Tenn.	17
Mowing Machines,	A. B. Allen,	City of	N. Y.	24
———	Frederic Gardiner,	Gardiner,	Me.	31
———	J. W. Shipman,	Springfield Cen.	N. Y.	24
———	F. W. Warner,	E. Haddam,	Conn.	31
Needle Threaders,—Casting	S. S. Burlingame,	Warwick,	R. I.	24
Nail Brush,	Wm. Thomson,	Buffalo,	N. Y.	31
Odometers,	A. T. Howard,	Hartford,	Vt.	3
Oil Cans,	James Jackson, Jr.,	Westerly,	R. I.	31
———,—Distillation of Coal	Benjamin Garvey,	City of	N. Y.	17
——— Feeder,	Joshua Turner,	Cambridgeport,	Mass.	31
Oils,—Fish	Wm. D. Hall,	Hamden,	Conn.	17
Ordnance,—Projectiles for	B. B. Hotchkiss,	Sharon,	"	24
———,—Repeating	J. A. Matthews,	St. Louis,	Mo.	31

Ore Separator, .	Samuel Man, .	Chicago,	Ill.	31
—— .	E. L. Seymour, .	City of	N. Y.	17
Paint Can, .	J. W. Masury, .	City of	N. Y.	10
Padlock, .	Roos & Spoehr, .	"	"	31
Paper Pulp,—Manufacture of	Ebenezer Clemo, .	Toronto,	C. W.	10
Pawl and Ratchet,	E. P. Russel, .	Manlius,	N. Y.	24
Pegging Jacks, .	Ephraim Everson, .	Haverhill,	Mass.	24
—— .	E. L. Harlow, .	Monmouth,	Me.	31
Pen and Pencil Case, .	G. E. Frew, .	Brooklyn,	N. Y.	31
—— Holder, .	Jonathan Warren,	"	"	31
Photographic Paper,—Silvering	Thompson & Wheaton,	City of	"	31
Piano-fortes, .	J. U. Fischer, .	"	"	10
—— .	G. H. Hulskamp, .	Troy,	"	10
Piano-forte Action,	F. W. Niehaus, .	Boston,	Mass.	3
Pianos,—Bridges for .	Wm. Compton, .	City of	N. Y.	10
——,—Tuning	J. B. Morris, .	Berryville,	Va.	3
Picture Frames,—Enameling	John Sperry, .	City of	N. Y.	10
Pins,—Manufacture of	T. and De G. Fowler,	Northford,	Conn.	31
Planing Machine, .	Benaiah Fitts, .	Worcester,	Mass.	31
——	W. N. Manning,	Salem,	"	17
Plotting Instrument, .	Samuel Barnett, .	Washington,	Ga.	17
Ploughs, .	E. B. Clark, .	Tallahassee,	Fla.	17
—— .	Wm. Griffin, .	Bennettsville,	S. C.	3
—— .	Loure Green, .	Great Bend,	Penna.	17
—— .	M. C. McCullers, .	Herndon,	Ga.	17
—— .	H. H. Robertson,	Kingston,	Mo.	10
——,—Ditching .	James Brooks, .	Romulus,	N. Y.	31
——,—Capstans	Elias Forbes, .	London,	Ohio,	24
——,—Gang .	T. S. Heptinstall, .	Mendota,	Ill.	17
—— .	J. C. Wilson, .	Cedar Hill,	Texas,	3
——,—Mole .	A. M. Karr, .	Mt. Pleasant,	Iowa,	24
—— .	C. W. Stafford, .	Burlington,	"	24
——,—Steam .	T. H. Burridge, .	St. Louis,	Mo.	31
Polishing Cabinet-work,	J. B. Morris, .	Ansonia,	Conn.	24
Potatoes,—Covering .	H. L. Bennett, .	Long Branch,	N. J.	31
Potato-diggers, .	G. C. Bartlett, .	Paris,	N. Y.	24
—— .	Daniel De Garmo, .	Rochester,	"	24
Potato-parer, .	Charles Disston,	Philadelphia,	Penna.	3
Presses,—Cotton .	Henry Mason, .	Lancaster,	Mass.	24
——,—— and Hay	H. F. Hicks, .	Grand View,	Ind.	24
——,—Hay .	I. S. Arnold, .	South Milan,	"	3
—— .	S. G. Randall, .	N. Britain,	Conn.	17
—— .	Sylvester Stevens, .	Sacramento,	Cal.	24
Prisons,—Iron, .	E. Jacobs, .	Cincinnati,	Ohio,	24
Propellers,—Rocking .	Edward Landis, .	Baltimore,	Md.	24
Pumps, .	Birdsill Holly, .	Lockport,	Ill.	24
—— .	J. A. C. J. Smith, .	Philadelphia,	Penna.	10
—— .	Chapman Warner,	Brooklyn,	N. Y.	31
—— for Locomotive Engines,	C. L. Rice, .	Milwaukie,	Wis.	17
Punching Machines,	Bradshaw & Coley,	Lowell,	Mass.	24
—— .	Chas. Hughes, .	N. Orleans,	La.	24
Quartz-crushing Apparatus,	Celestino Dominguez,	San Francisco,	Cal.	3
Railroad Bolts,—Fastening Nuts	G. W. R. Bayley, .	Brashear,	La.	24
—— Cars,—Couches for	Wm. A. Brown,	Philadelphia,	Penna.	17
——,—Dumping	A. B. Cooley, .	"	"	3
——,—Journal Box	Josiah Ashenfelder,	"	"	31
——,—Seal Lock for	J. H. Lyon, .	City of	N. Y.	17
——,—Stop. & Start.	E. S. Ritchie, .	Brookline,	Mass.	3
—— Cattle Car, .	J. B. Shafer, .	Grafton,	Va.	31
—— Gates, .	Lester Butler, .	Kenosha,	Wis.	17
—— .	McNair & Elliott, .	Augusta co.,	Va.	17

Railroad Switches,	J. C. Whitson,	Marion,	N. C.	17
Rakes,—Horse	Wm. & Thos. Schnebly,	Hackensack,	N. J.	10
——— ———	Seidle & Eberly,	Mechanicsb'gh,	Penna.	3
———,—Horse Hay	A. R. Hurst,	Chambersburg,	"	10
Rat Traps,	Leonard Parker,	Winterset,	Iowa,	17
Refrigerator,	W. W. Stannard,	Buffalo,	N. Y.	31
Register Point,	J. W. Cliff,	Rochester,	"	31
Roofing, Belting, &c.,—Fabric	J. B. Wands,	Memphis,	Tenn.	31
——— and Cement,—Comp.	Alexander Asboth,	City of	N. Y.	3
Rotary Engines,	S. T. Russell,	Ottawa,	Ill.	31
Sash-fastener,	T. L. Braynard,	City of	N. Y.	24
———	Julius Hornig,	Newark,	N. J.	24
Sash Stops to Windows,	N. L. McFarlan,	Syracuse,	N. Y.	3
Sausage-stuffer,	Jacob Kinzer,	Pittsburgh,	Penna.	31
Sawing Bevels on Laths,	G. W. Corson,	Corson's P. O.	"	10
——— Boards,—Machine for	Timothy Drake,	Windsor,	Conn.	3
——— Machine,	Carey Pitts,	Troy,	N. Y.	3
———,—S'm cross-cut	S. M. King,	Lancaster,	Penna.	31
——— Staves,—Machine for	H. H. Evarts,	Chicago,	Ill.	10
———	W. W. and J. B. Hurlbut,	"	"	3
Saws,—Straining Scroll	Chas. Rose,	Allentown,	Penna.	3
Saw-mills,	G. H. Clemens,	Cincinnati,	Ohio,	10
Staves,—Machine for Jointing	J. F. & I. W. Bristow,	Vevay,	Ind.	3
Scaffolds,—Supporting	J. K. Lewis,	Rising Sun,	"	10
Scissors,	J. G. DeCoursey,	Philadelphia,	Penna.	24
Screw Wrenches,—Heading	L. and A. G. Coes,	Worcester,	Mass.	31
Screws,—Making	Justus Griggs,	Utica,	N. Y.	31
Seed Planters,	G. T. Bennett,	Mt. Olive,	N. C.	17
———	George Hetrick,	Reidsburg,	Penna.	10
Seeding Machines,	G. W. Clark,	Mt. Washington	Ohio,	10
———	Ezra Emmert,	Franklin Grove,	Ill.	10
———	J. S. Gage,	Dowagiac,	Mich.	10
———	Hermann Kaller,	Perry,	Ill.	17
———	W. P. Penn,	Belleville,	"	17
———	Edwin Ritson,	Sanbornton,	N. H.	10
———	D. J. Vail,	Industry,	Ill.	31
Segars,	Isaac Lindsley,	Providence,	R. I.	31
Sewing Machines,	Ezekiel Booth,	Troy,	N. Y.	3
———	John First,	City of	"	3
———	W. C. Hicks,	Boston,	Mass.	24
———	Hugo Mueller,	City of	N. Y.	3
———	J. S. McCurdy,	Brooklyn,	"	3
———	Penny & Botsford,	Wooster,	Ohio,	3
———	W. A. Sutton,	City of	N. Y.	17
———	C. H. Willcox,	"	"	31
———,—Shuttles	Planer & Siegl,	"	"	17
———,—Spool Pins	George Churchill,	Hartford,	Conn.	17
Ships Boats,—Lowering, &c.,	J. A. Davis,	Portsmouth,	Va.	10
—— Rigging,—Setting-up	E. U. Thompson,	Bristol,	Me.	17
Shoemakers Last,	J. C. Plumer,	Portland,	"	17
Shovels,	J. U. Fiester,	Winchester,	Ohio,	17
Signal Lantern,	T. F. Woodward,	S. Reading,	Mass.	10
Silk in the Hank,—Stretching	Lucius Dimock,	Hebron,	Conn.	17
Skates,	Jeremiah Heath,	Providence,	R. I.	3
———	L. and I. J. White,	Buffalo,	N. Y.	10
Smoothing-irons,—Heating	J. E. Johnson,	Brockport,	"	31
———,—Self-heating	B. O. Ball,	Greensburgh,	Ohio,	10
Smut Machines,	Drake & Hewett,	Marshall,	Mich.	31
———	Samuel Favinger,	Philadelphia,	Penna.	17
———	Richard Mohler,	Lancaster,	"	24
Soldering Irons,	Lester Patee,	Peoria,	Ill.	3
Springs,—Adjustable Carriage	George Palmer,	Littlestown,	Penna.	24

Springs,—Car .	McCormick & Jerrold,	Paterson,	N. J.	17
Spring,—Compensating Lever	Wm. S. Pratt, .	Williamsburgh,	N. Y.	24
Spoke Machine, .	S. B. Wilkins, .	Milton,	Penna.	10
Stamping Heads,—Casting	P. W. Gates, .	Chicago,	Ill.	31
Stave Machine, .	W. M. Sloan, .	Buffalo,	N. Y.	17
Stave-jointing Machines,	C. M. Young, .	Sinclairsville,	"	31
Steam Boilers, .	Bean & Collins,	Manchester,	N. H.	3
——— .	J. H. Boardman, .	City of	N. Y.	31
——— .	John Brown, .	"	"	24
——— .	Jonathan Vaile, .	Miami,	Ohio,	24
———,—Alarm Gauge	C. T. Pangborn,	Brooklyn,	N. Y.	24
———,—Feeding Appar.	Thomas Shaw, .	Philadelphia,	Penna.	31
———,—Fusible Plugs	I. C. Saunders, .	Trenton,	Mich.	24
———,—Low-water Det.	J. W. Hopper, .	City of	N. Y.	24
———,—Valves for	D. R. Prindle, .	E. Bethany,	"	3
——— Engines, .	W. Birkbeck, .	Jersey City,	N. J.	3
———,—Boiler-feeders	E. A. Wood, .	Utica,	N. Y.	3
———,—Governors for	Jerome Wheelock, .	Worcester,	Mass.	3
———,—Pumps for	J. F. Hamilton, .	Pittsburgh,	Penna.	24
——— Generator .	Benjamin Garvey, .	City of	N. Y.	17
——— Land Carriages,	C. H. Baker, .	Red Wing,	Minn.	3
——— Pressure Gauge, .	Wm. P. Parrott, .	Boston,	Mass.	24
Steering Apparatus,	E. W. Tarbell, .	"	"	31
——— Vessels,—Mode of	F. E. Sickles, .	City of	N. Y.	17
Stereotype Plates,—Making	S. H. Mix, .	Schoharie,	"	10
Stone-dressing Machines,	Francis Schwalm, .	Joliet,	Ill.	10
Stone,—Machine for Crushing	G. A. Rollins, .	Nashua,	N. H.	17
Stoves, .	Charles Jones, .	Philadelphia,	Penna.	17
——— .	S. H. Ransom, .	Albany,	N. Y.	24
———,—Coal .	Lucius Crandall, .	Plainfield,	N. J.	24
———,—Cooking	Cavanaugh & Lazear,	Jersey City,	"	24
——— .	Johnson & Wansbraugh,	Cincinnati,	Ohio,	31
Stove-pipes,—Machine for Form.	James Rogers, .	Sa. Clara co.,	Cal.	31
Straw Cutters, .	Samuel Ring, .	Cleveland,	Ohio,	24
——— and Stalk Cutters,	Preston, Jr., & Farnham,	Corning,	N. Y.	31
Submarine Operator, .	G. W. Martin, . .	W. Morrisania,	"	24
Sugar,—Appar. for Draining	J. J. Unbehagen,	Baton Rouge,	La.	10
——— Cane,—Wind-rowing	B. A. Jenkins, .	Whitewater,	Wis.	3
——— Kettle Trains,	J. P. Henderson,	Franklin,	La.	10
Surveyors Tackle Case, .	W. H. Paine, .	Sheboygan,	Wis.	10
Sweeping Streets,—Machine for	G. M. Ramsay, .	City of	N. Y.	10
Switch Plates for City R. Rs,	Wm. Ebbitt, .	"	"	24
Syringes, .	Benjamin Irving,	"	"	10
——— .	E. G. Stevens, .	Biddeford,	Me.	10
Tanning,—Compounds for	D. J. Cochran, .	Centerville,	Ind.	17
——— Extracts, .	James Connell, .	Port Huron,	Mich.	17
Telegraphic Repeaters,	J. J. Clark, .	Philadelphia,	Penna.	24
Thills to Vehicles,—Attaching	L. C. Miner, .	Hartford,	Conn.	17
Thread-polishing Machines,	L. C Ives, .	"	"	17
Threshing Machines, .	W. W. Dingee, .	York,	Penna.	24
———	S. E. Oviatt, .	Richfield,	Ohio,	10
——— Peas and Beans,	J. T. Smith, .	Portsmouth,	Va.	24
Timber,—Comp. for Preservation	John Dain, .	Utica,	Ohio,	31
Tobacco Boxes, .	Friedrick & Walter, .	City of	N. Y.	17
——— .	Henry Kurth & others,	Brooklyn,	"	31
———,—Pressing .	John Henry, .	Lynchburgh,	Va.	24
Tool Sharpener,—Edge	S. W. Wood, .	Watertown,	N. Y.	24
Trees,—Machine for Felling	A. P. Torrence, .	Oxford,	Ga.	3
——— from Insects,—Protecting	Nathaniel Potter, Jr.,	S. Dartmouth,	Mass.	10
Trusses, .	Henry Dalton, .	City of	N. Y.	3
———,—Belt .	J. C. Rainbow, .	New Brighton,	Penna.	31
———,—Hernial Spring	D. L. D. Sheldon, .	San Francisco,	Cal.	31

Tubes,—Aesophagus,	N. Q. Munger,	Brookfield cen.	Wis.	10
———,—Forming Seamless	C. E. L. Holmes,	Waterbury,	Conn.	24
Tweers,	Tolman & Blodget,	N. Orange,	Mass.	10
Type-metal with Brass,—Coat'g	Joseph Corduan,	Brooklyn,	N. Y.	17
Varnish,—Polishing	Bennett & Stover,	Boston,	Mass.	3
Vermin,—Appar. for Destroying	Levi Disbrow,	Oswego,	N. Y.	31
Vinegar,—Manufacture of	F. M. Ruschhaupt,	City of	"	31
Warming Apparatus,	J. H. Davis,	Woburn,	Mass.	31
Washing Machine,	John Contrell,	City of	N. Y.	10
———	Wm. Gowen	Wausau,	Wis.	17
———	A. B. Harlan,	Ercildoun,	Penna.	17
———	S. T. Vallett,	Providence,	R. I.	3
Watches,	O. H. Woodworth,	Coffeeville,	Miss.	17
Watch Chains,—Hooks for	J. R. Lounsberry,	N. Eng. Village,	Mass.	10
Watchmakers Lathes,	Albert Wild,	City of	N. Y.	17
Water Closet,—Portable	Enoch Hidden,	"	"	24
Water,—Method of Cooling	Thomas Byrne,	Baton Rouge,	La.	10
——— Metres,	Gerard Sickles,	Roxbury,	Mass.	24
——— Pipes to Buildings,	Wm. Austin,	Philadelphia,	Penna.	3
——— Wheels,	Closs & Pyle,	Decatur,	Ind.	10
———	Henry Fellows,	Bloomfield,	"	24
———	James Martin,	Florence,	Ala.	3
———	J. M. Perkins,	Chicago,	Ill.	24
———	J. W. Truax,	Richford,	Vt.	24
Wheels,—Adjusting Tire on	W. S. Harrison,	Carson's Land.	Miss.	3
——— for Gun Carriages, &c.,	C. F. Brown,	Warren,	R. I.	10
Whiffle-trees for Vehicles,	Ignaz Ramminger,	City of	N. Y.	17
Windmills,	Arnold De Witt,	Brooklyn	"	3
———	Henry Glover,	E. Douglas,	Mass.	10
Windows,—Appar. for Cleaning	George Munce,	St. Louis,	Mo.	31
Window Sashes,—Elevator for	Samuel Mills,	City of	N. Y.	31
——— Stop and Fastening,	Turner Williams,	Providence,	R. I.	17
Wrench,	R. P. Buttles,	Mansfield,	Penna.	3
Yokes,—Bow of Ox	Warren & Silliman,	Chester,	Conn.	17

EXTENSIONS.

Horse-powers,	Sheldon & Cary,	Chili,	N. Y.	3
Looms,	W. D. Dutcher,	Milford,	Mass.	3
Netting Machines,	John McMullen,	Baltimore,	Md.	3

ADDITIONAL IMPROVEMENTS.

Altitudes of the Sun,—Taking	Frederick Yeiser,	Indianapolis,	Ind.	17
Clover Hullers,	Anthony Overocker	McHenry,	Ill.	24
Grates,	Joseph Tiberi,	St. Louis,	Mo.	17
Railroad Cars,—Roofs for	A. P. Winslow,	Cleveland,	Ohio,	31
Shoe Heels,—Cutting & Finish.	W. F. Edson,	Philadelphia,	Penna.	24

RE-ISSUES.

Air Engines,	Philander Shaw,	Boston,	Mass.	17
Artificial Legs,	Douglas Bly,	Rochester,	N. Y.	3
Bedsteads,—Folding	T. B. Bleecker,	City of	"	24
Canal Boats,—Paddle Wheels	Reuben Jane,	Otego,	"	3
Fences,—Panels of Portable	Chas. Van DeMark,	Oak Corners,	"	10
Gas Regulators,	Salmon Bidwell,	City of	N. Y.	31
Grain Separators & Cleaners,	W. M. Arnall,	Sperryville,	Va.	10
———,—Shoe for	Hiram Aldridge,	Michigan City,	Ind.	31
Harvesters and Binders (2 pats.),	H. Baldwin, Jr.,	Washington,	D. C.	3
Mowing Machines (7 patents),	Ephraim Ball,	Canton,	Ohio,	17
Oilcloth,—Printing 2 "	James Albro,	Elizabeth,	N. J.	3
Paper Pulp,—Manu. 2 "	Palser & Howland,	Ft. Edward,	N. Y.	3
Photo-lithography,	Cutting & Bradford,	Boston,	Mass.	31

Printing Presses (2 patents),	G. P. Gordon,	City of	N. Y.	31
Reaping Machines, 3 "	W. H. Seymour,	Brockport,	"	10
Saw-mills—Circular	N. G. Norcross,	Lowell,	Mass.	10
Seeding Machines,	A. E. Bonham,	Elizabethtown,	Ohio,	10
Steam Boilers,—Feed-water	G. W. Rains,	Newburgh,	N. Y.	24
Windlasses,—Ships	Wm. H. Gilmore,	Worcester,	Mass.	31

DESIGNS.

Gridiron,	Elnathan Peck,	New Britain,	Conn.	17
Hub Bands,	B. S. Pardee,	Mt. Carmel,	"	31
Range,—Cooking	Sanders & Vedder,	City of	N. Y.	31
Spoon Handles,	H. C. Foster,	Worcester,	Mass.	3
Stove,	Isaac DeZouche,	St. Louis,	Mo.	3
——,—Coal	Daniel Hathaway,	Troy,	N. Y.	31
——,—Cook's	W. W. Stanard,	Buffalo,	"	24
—————— (4 patents),	G. Smith & H. Brown,	Philadelphia,	Penna.	3
——,—Cooking (2 cases)	S. H. Ransom,	Albany,	N. Y.	3
—————— "	W. W. Stanard,	Buffalo,	"	31
—————— "	G. Smith & H. Brown,	Philadelphia,	Penna.	3
——————	N. S. Vedder,	Troy,	N. Y.	31
——,—Parlor	S. H. Ransom,	Albany,	"	3
————	W. W. Stanard,	Buffalo,	"	31
——,—Six-plate	Daniel Hathaway,	Troy,	"	31
——,—Plates of a Cook's	G. Smith & H. Brown,	Philadelphia,	Penna.	17
Trade Mark,	D. L. Meineke,	St. Louis,	Mo.	31

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 20, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President,
Isaac B. Garrigues, Recording Secretary, } Present.

The minutes of the last meeting were read and approved.

Donations to the Library were received from la Société Industrielle de Mulhouse, France; the Hon. P. F. Thomas, Commissioner of Patents, and Frederick Emerick, Esq., Washington, D. C.; the Massachusetts Charitable Mechanics Association, Boston, Mass.; Thomas Ewbank, Esq., and Dr. Martyn Paine, City of New York; the Wilmington Institute, and Edward Tatnell, Esq., Wilmington, Del.; the Maryland Institute, Baltimore, Md.; John A. Roebling, Esq., Trenton, N. J.; Dr. Charles M. Wetherill, Lafayette, Ind.; the Harrisburgh, Portsmouth, Mountjoy, and Lancaster Railroad Co., Messrs. Moses Thomas & Sons, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of August was read.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (9) were proposed, and the candidates proposed at the last meeting (12) duly elected.

Mr. Howson exhibited a collection of fire arms manufactured by

Christian Sharps, Esq., (the well-known inventor of Sharps' rifle,) at his establishment in West Philadelphia.

The first arm exhibited was a specimen of the standard military carbine, arranged to load at the breech, and having the patent self-priming device. This arm was manufactured in New England from Mr. Sharps' designs, and is, in most respects, similar to those made for the United States, as well as for several European governments. It has, however, an improvement in the self-priming arrangement, whereby the magazine of caps may be reserved for emergencies, and caps of ordinary construction used.

Two beautiful specimens of light breech-loading rifles with barrels of smaller calibre than the above were next exhibited. These were arranged to receive a metallic case containing the charge of powder and ball; the case after being discharged is withdrawn from the breech to be again used after it has received a new charge. A suitable number of these cases are carried in a pouch by the sportsman, who recharges them at his leisure.

Several specimens of Sharps' patent breech-loading repeating pistol were exhibited and explained. This fire arm consists of a barrel block with four bores, the block being arranged to slide to and fro on the stock. A metallic cartridge is inserted into each bore, the block moved up to the stationary breech of the stock and there locked, when the fire arm is ready for being discharged. The hammer is provided with a revolving nipple which strikes each cartridge in succession, the movement of the nipple being effected by the cocking of the hammer.

Mr. Howson exhibited the several pieces of which one of these pistols was composed, in their crude state, remarking that each piece was reduced to its proper form by machinery, with an exactitude which no manipulation could accomplish, every portion of one pistol being an exact counterpart of the corresponding portions of another pistol; and that when the extent and beauty of the workmanship is considered, it is almost impossible to conceive how these weapons can be manufactured so rapidly as to be retailed for the low price of ten to twelve dollars; but that a visit to Mr. Sharps' factory, and an examination of the beautiful and effective tools there used, and a knowledge of the fact that subdivision of labor is there carried out to perfection, would solve the mystery.

Vast quantities of these arms are sent to all parts of the Union by Messrs. Handy & Brenner, of this city, the sole agents for the sale of Sharps' fire arms.

Mr. H. subsequently explained to the meeting Mr. Sharps' improvements in the construction of metallic cartridges, which are destined to replace the ordinary paper cases. These cartridges, first used in France, consist of thin metal cases, with an enlargement at one end for containing the detonating material, and a bullet at the opposite end; the interior of the case containing the charge of powder, and the cartridges being exploded by causing the hammer to strike the edge of the enlargement.

It is necessary, in order that the spent cartridges may be readily

extracted from the bore of the barrel, that the cases should have a slight taper. In order to impart this taper to, and to form the enlargement on, a hollow metal cylinder closed at one end, Mr. Sharps uses a die composed of two steel blocks, in which is formed a chamber of the shape of the desired case. Into this chamber is dropped the hollow cylinder, the latter being subsequently partially filled with water. A plunger is now inserted into the mouth of the cylinder, and a smart blow imparted to it, thereby causing the metal to expand and adapt itself to the shape of the chamber; after which the now completed case is withdrawn from the dies.

By this contrivance, and others of equal simplicity and ingenuity for spreading the detonating material in the enlargement of the case and confining it therein, Mr. Sharps is enabled to make the most perfect metallic cartridges at the same cost as those made of paper.

It was remarked, in conclusion, that Mr. Sharps had devoted the greater part of his life to the experimenting with and the designing of improvements in fire arms and projectiles, and this with such success, that the superiority of his ware was universally acknowledged: many European regiments being armed with the celebrated Sharps' rifle.

Mr. Thomas E. McNeill exhibited a very beautiful and ingenious steam gauge invented and patented by Mr. J. E. Wootten. It consists of a steam chamber formed by riveting together at their edges two disks of very hard rolled sheet brass. The dilation of these disks under pressure, communicates motion to the index pointer, by means of a coarse threaded screw cut upon the spindle to which the pointer is attached. A hair spring is attached to the spindle for the purpose of keeping its point at all times in contact with the front disk, by which means, an accurate indication of pressure is obtained.

BIBLIOGRAPHICAL NOTICE.

The Manufacture of Vinegar: its Theory and Practice; with especial reference to the quick process. By CHAS. M. WETHERILL, Ph. D., M. D. Philadelphia: Lindsay & Blakiston, 1860. 12mo. pp. 300.

This is an excellent theoretical and practical treatise upon a subject which possesses great interest for every one, especially to those who, living at a distance from manufacturing centres, are here shown how easily and with how little expenditure of capital they may ensure for themselves purity and proper strength of an article of such domestic importance. But the book has another and perhaps higher value, as a type of what such a treatise should be; the clear precise statement of its facts, its logical method, and absence of all parade of unnecessary learning, are the exact qualifications which are necessary to make a treatise on the manufacture of any speciality useful and interesting; and if more of those who have heretofore professed to write such treatises had attended to this, we should have had our

manufacturers and people much better informed upon such subjects than they now are.

We need not say to any one who reads this book, that its author is an excellent chemist; that is manifest as well by what he does not say as by what he does; but we take the opportunity of acknowledging the receipt of another investigation by him on the subject of the relative cost of light from different materials, which will be of great importance for the region of country in which he resides.

The book under consideration is very excellently got out by the well-known publishers, and is worthy of being read by all, and of being studied by all who are in any way interested in the manufacture of vinegar. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

AUGUST.—The temperature of the month of August was a degree and a half below that of July last, about one degree above that of August, 1859, and about half a degree above the average temperature of August for the last ten years. It will be seen, by the table of comparisons given below, that this difference of temperature occurred principally at 2 o'clock in the afternoon, the means for 7 A. M. and 9 P. M., for 1860, being almost identical with those for the same hours for ten years; while the mean for 2 P. M., in 1860, was two degrees higher than the average for the same time.

The warmest day was the 5th, of which the mean temperature was 83°. The highest degree indicated by the thermometer was 95° on the 10th of the month; the mean temperature of that day was 82·7°. From the 4th till the 10th, the temperature did not fall below 70°, night or day. On the night of the 10th, however, rain fell, the wind changed from the south-west to the north-west, and, during the next day, the thermometer indicated an average fall of nearly 12°.

On the 13th a thunder-storm occurred. Rain fell in heavy showers all the morning; but about two o'clock in the afternoon the lightning became very vivid and the rain came down in torrents. In two hours, from two till four o'clock, three inches and thirty-five one-hundredths of an inch of rain fell—about four times as much as fell during the whole of the month of July. During the storm, a man was instantaneously killed by lightning in the southern part of the city. The rain continued heavy and steady until 11½ A. M., on the morning of the 14th.

The 14th was the coldest day of the month, the average temperature being 65°. The lowest degree indicated by the thermometer was 55° on the morning of the 15th.

The barometer was highest on the 16th, when it indicated a pressure equal to 30·026 inches; and lowest on the 25th, when it marked 29·632 inches. The average height of the barometer for the month

was very nearly the same as for August, 1859, and but three-hundredths of an inch lower than the average for the last ten years.

On the 23d, a very heavy rain-storm passed over the northern portion of the city. It is said that, at Manayunk, over ten inches of rain fell; while, in the centre of the city, less than two-tenths of an inch was collected in the rain-gauge.

The whole amount of rain that fell during the month was nine inches and twenty-six hundredths of an inch, which is a greater quantity than has fallen in the month of August for ten years. The nearest approach to it was in August, 1857, when a little over eight inches (8·039) fell. The average amount for this month is 4·714 inches.

There were five days of the month entirely clear, and two on which the sky was completely covered with clouds at the hours of observation.

A Comparison of some of the Meteorological Phenomena of August, 1860, with those of August, 1859, and of the same month for ten years, at Philadelphia.

	Aug., 1860.	Aug., 1859.	Aug., 10 years.
Thermometer.—Highest,	95°	97°	97°
" Lowest,	55	51½	47
" Daily oscillation,	18·80	20·50	15·90
" Mean daily range,	3·80	3·10	3·80
" Means at 7 A. M.,	70·13	69·03	70·29
" " 2 P. M.,	82·87	82·16	80·74
" " 9 P. M.,	73·29	72·39	73·37
" " for the month,	75·43	74·53	74·80
Barometer.—Highest,	30·026 in.	29·998 in.	30·255 in.
" Lowest,	29·632	29·671	29·356
" Mean daily range,	·090	·070	·092
" Means at 7 A. M.,	29·848	29·847	29·879
" " 2 P. M.,	29·813	29·801	29 851
" " 9 P. M.,	29·834	29·832	29 869
" " for the month,	29·832	29·827	29·866
Force of Vapor.—Means at 7 A. M.,	·580 in.	·551 in.	·584 in.
" " " 2 P. M.,	·584	·551	·596
" " " 9 P. M.,	·603	·581	·613
Relative Humidity.—Means at 7 A. M.,	77 per ct.	75 per ct.	77 per ct.
" " " 2 P. M.,	52	50	56
" " " 9 P. M.,	73	72	74
Rain, amount in inches,	9·260	4·447	4·714
Number of days on which rain fell,	13	8	10
Prevailing winds,	N.80°54′W·150	S.26°34′E.·055	S.83°35′W·104

Summer.—The meteorological summer, consisting of the months of June, July, and August, was, during this year, distinguished by many interesting phenomena which have been particularly noticed in the reports for the separate months. The eclipse of the sun, the extraordinary meteor of the 20th of July, the heated wind storms of Kansas and throughout the South-West, the unusually great number

of thunder-storms, and the destructive tornados in several of the Western States, will make the summer of 1860 a memorable one. But few of these storms reached Philadelphia, and those that did reach us seem to have spent their fury to a great degree before their arrival.

The pressure of the atmosphere was considerably less than the average, as will be seen by reference to the table of comparisons.

The temperature was intermediate between that of the summer of 1859, and the average for the nine past summers, being about three-quarters of a degree above the former, and the same quantity below the latter.

The force of vapor and relative humidity were both below the average.

The rain was half an inch more than fell in last summer, but nearly an inch more than the general average for the season. More than three-fourths of it, however, fell in the month of August.

The number of days on which rain fell was 33, being one more than usual.

The prevailing winds during this summer came from a point a little north of west, while their average direction for nine years is about twice as far south of west.

A Comparison of the SUMMER *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Summer, 1860.	Summer, 1859.	Summer, for 9 years.
Thermometer.—Highest, ...	95·5°	97°	100·5°
" Lowest, . . .	52·0	42·0	42·0
" Daily oscillation, .	19·20	19·90	16·10
" Mean daily range, .	4·33	4·60	4·10
" Means at 7 A. M., .	70·11	69·36	71·20
" " 2 P. M., .	81·71	80·53	81·43
" " 9 P. M., .	72·23	71·48	74·01
" " for the summer,	74·68	73·79	75·55
Barometer.—Highest, ...	30·123 in.	30·202 in.	30·281 in.
" Lowest, ...	29·343	29·520	29·182
" Mean daily range, . .	·097	·095	·094
" Means at 7 A. M., .	29·805	29·866	29·859
" " 2 P. M., . .	29·769	29·825	29·828
" " 9 P. M., .	29·789	29·848	29·844
" " for the summer,	29·788	29·847	29·844
Force of Vapor.—Means at 7 A. M.,	·529 in	·535 in.	·577 in.
" " " 2 P. M., .	·518	·555	·588
" " " 9 P. M.,	·547	·557	·607
Relative Humidity.—Means at 7 A. M.,	71 per ct.	72 per ct.	74 per ct.
" " " 2 P. M.,	48	52	55
" " " 9 P. M.,	68	71	71
Rain, amount in inches, ...	13·817 in.	13·591	12·979
Number of days on which rain fell,	33	31	32
Prevailing winds, ...	N. 88°27′ W·165	S. 73°8′ W. ·182	S. 74°27′ W·159

Abstract of Meteorological Observations for July, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° Height 618 ft. WM. HEYSER					FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. BAIRD, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom.	Thermom.		Force of vapor	Relative humidity	Thermometer.		Prevailing winds.
July.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P. M.	2 P. M.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.	Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct	Inches.	Direc.	Inch.	°	°	Inch.	Per ct	°	°	Direc.
1	29·817	·134	74·3	17	11·0	·238	29	0·006	N.	29·249	71·0	9·0	·564	80	67·7	6·7	N W.
○ 2	29·867	·066	77·0	21	2·7	·463	40		N W.	29·294	73·0	5·0	·718	77	69·3	5·3	?
3	29·906	·074	71·7	4	5·3	·634	78	0·113	(var.)	29·162	73·7	6·7	·832	71	70·8	3·7	W.
4	29·632	·176	79·0	29	7·3	·743	58	0·808	(var.)	28·740	79·7	2·7	·809	79			W.
5	29·545	·067	78·7	24	4·7	·584	58		(var.)	28·913	75·0	4·7	·746	64	74·0		(var.)
6	29·810	·265	64·2	14	14·5	·378	53		N E.	29·174	64·3	13·7	·403	67	62·0	12·0	E.
7	29·884	·078	69·5	19	5·3	·289	33		E N E.	29·270	67·3	3·0	·408	52	66·7	5·3	(var.)
8	29·732	·152	70·8	20	5·0	·461	47	0·018	S S W.	29·068	74·0	3·3	·527	57	70·3	3·7	(var.)
9	29·675	·106	80·0	21	9·2	·595	44		S W.	29·143	77·3	6·7	·582	50	74·0	3·7	W
10	29·515	·145	84·3	22½	4·3	·560	37		S W.	29·193	81·0	5·3	·556	43	78·0	4·0	W.
☾ 11	29·902	·085	76·3	14	6·0	·417	36		N N W.	29·304	75·7	6·0	·596	58	68·2	12·3	(var.)
12	29·917	·014	71·3	20	5·0	·321	32		N W	29·342	68·0	6·7	·371	49	61·8	4·3	N.
13	29·933	·036	72·3	22	1·0	·355	36		(var.)	29·339	67·7	2·0	·358	46	69·7	2·3	?
14	29·936	·019	75·8	23	4·0	·404	36		N E.	29·340	70·7	3·0	·356	38	71·3	7·7	W.
15	29·908	·036	78·6	20	3·5	·384	30		S W.	29·290	77·0	9·7	·512	45	74·0	3·3	W.
16	29·752	·156	84·0	25½	5·2	·606	34		S W.	29·186	80·7	3·7	·543	42	79·0	6·0	S W.
17	29·799	·068	81·0	18	3·7	·431	32		N W.	29·225	79·3	4·7	·531	44	71·7	7·3	N.
● 18	29·929	·129	79·0	25	2·7	·465	36		S E.	29·289	79·0	4·3	·644	52	74·7	0·3	S.
19	29·812	·116	82·8	19	3·8	·672	49	0·006	S W.	29·237	80·0	5·0	·819	65	74·0	2·0	(var.)
20	29·755	·057	87·7	22½	4·8	·675	41		N W.	29·187	83·3	4·0	·809	48	79·7	5·0	?
21	29·579	·176	81·7	16	6·0	·657	51	0·084	S W.	29·002	81·0	3·3	·783	61	72·0	7·7	W.
22	29·734	·155	75·2	15	5·5	·368	33		(var.)	29·134	73·0	11·3	·497	46			?
23	29·568	·146	77·8	17	1·7	·671	48	0·110	W.	29·010	75·3	5·0	·568	55	66·0		N W.
24	29·840	·252	71·7	21	6·2	·288	29		(var.)	29·264	70·0	5·0	·392	44	64·3	2·3	N W.
☽ 25	29·926	·085	75·5	24	3·5	·514	46		S W	29·332	73·0	3·3	·674	56	69·0	4·7	N W.
26	29·851	·076	78·7	26	1·2	·756	67	0·014	(var.)	29·228	76·3	3·0	·447	40	76·0	7·0	W.
27	29·806	·096	76·2	20	1·8	·564	47	0·184	(var.)	29·253	76·3	3·7	·585	55	68·3	7·7	N W.
28	29·956	·137	72·2	21½	4·0	·403	39		S E.	29·363	74·7	3·7	·660	59	74·0	5·7	(var.)
29	29·782	·154	74·7	15½	8·5	·667	69		S E.	29·117	76·3	3·0	·819	78	75·3	5·3	S W.
30	29·617	·168	81·8	16	7·2	·630	51		S E.	29·077	77·7	2·7	·690	63	69·7	5·7	N W.
31	29·620	·014	81·7	24	2·8	·616	44		S W.	29·106	75·0	2·7	·637	62	67·7	2·0	(var.)
Means	29·791	·112	76·9	20	5·0	·506	45	0·851	S 70° W	29·186	75·2	5·2	·595	56	70·5	5·5	N 66½° W.

Abstract of Meteorological Observations for July, 1830; made in Adams, Dauphin, Northumberland, Centre, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

// JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

NOVEMBER, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Notes of Ship-Building in New York and Vicinity.

JUDGING from present indications, it would seem that the shipping business of New York and its vicinity is to experience a great revival from the dullness and stagnation which has heretofore prevailed. During the past four years, there has been a general depression among ship-builders, whilst ship-owners have been steadily sinking immense sums of money, much less realizing those handsome incomes, which, a few years since, marked the business of navigation; they have not only experienced very light freights, but have been compelled to see their once magnificent and busy vessels lying idle, and rotting at their docks for lack of employment.

But now, the aspect has changed, and it is sincerely hoped that the gratifying signs at present universally manifest, will not be spasmodic and soon pass away, but that prosperity of trade in general, and a succession of good crops, will follow and create a constant demand not only for the fine vessels afloat, but for new and improved ones, which New York and vicinity have almost unlimited means of supplying.

The cause of the present activity in our ship-building is easily explained. It is the great abundance of crops throughout the whole extent of our Union, for which the comparative dearth in Europe necessarily creates an extensive demand; this is, undoubtedly, the prin-

cipal cause, but there are others, equally important, to which it is attributable, viz: the unexampled success attending the many efforts of our respective ship-builders.

Science and art have extended their aid in no other department of handiwork more particularly than in this. American skill and American ingenuity have produced models in this respect which are everywhere recognised as the best; and it is but recently that special agents were sent to this country by foreign powers to superintend the erection of vessels intended for them; but of this a single word hereafter.

The prominent feature of the work as at present in progress throughout the various ship-yards, is the large number of steamers upon the stocks. But few packet ships are in course of construction: in fact, the smallest vessels are being built with steam power to propel them. This little circumstance only proves how rapidly the revolution from canvass to steam is progressing, and indicates that ere long sailing vessels will be entirely superseded by steamers, particularly for the coasting trade.

Visiting a ship-yard to me is always pleasant, but at the present period far more so than usual; as the busy hum, the merry chorus of the ringing axes and clanking hammers, present indubitable evidence of the great activity with which the work is progressing. Annexed will be found a review of the operations now in progress at our yards, which will give an impression of the state of the business.

The Steamer Guadalquiver.

Hull built by Jacob Westervelt & Co., New York. Machinery to be constructed by a foundry in Cuba. Owners, parties in Havana. Intended service, coasting around the island of Cuba.

Hull.—Length on deck, 160 feet 6 ins. Breadth of beam (molded), 23 feet 8 ins. Depth of hold, 10 ft. Depth of hold to spar deck, 10 ft. 3 ins. Frames—molded, 11 ins.—sided, 5½ ins.—apart from centres, 20 ins., and square fastened with copper, &c. Draft of water, 4 feet; when fully equipped for service, with her engines and coal, will draw 6 ft. of water Masts, two—Rig, schooner. Tonnage, 375 tons.

Machinery.—To be put in immediately after her arrival in Cuba. Of its dimensions or description, I have no knowledge.

Remarks.—This vessel is of a beautiful model, with very sharp and easy lines. Her frame is of live oak; the keelsons and ceiling of yellow pine; the planking is of yellow pine and white oak. The decks are of yellow pine, and the combings of mahogany.

The Steamer John P. King.

Hull built by Jacob Westervelt & Co., New York. Machinery in process of construction by the Allaire Works, New York. Owners, Spofford, Tileston & Co. Intended service, New York to Charleston, S. C.

Hull.—Length on deck, 236 ft. Breadth of beam (molded), 36 ft. 6 ins. Depth of hold, 13 ft. 8 ins. Depth of hold to spar deck, 21 feet. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins., and very securely fastened with copper, &c. Tonnage, 1572 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return flue. Length, 26 feet. Breadth, 12 ft. 3 ins. Height, 12 ft. 3 ins.

PADDLE WHEELS.—Diameter over boards, 28 ft. Material of iron. Number, 24.

Remarks.—This steamer is very strongly built, her frame being white oak throughout. Her model is handsome and such as to insure great speed. This vessel was named in honor of the President of the Georgia Railroad. Capt. Richard Adams, formerly of the *James Adger*, will command her.

The Steamer John P. Jackson.

Hull built by Devine Burtis, Red Hook, L. I. Machinery in process of construction by Wm. Birkbeck, Jersey City. Owners, New Jersey Ferry Company. Intended service, New York to Jersey City.

HULL.—Length on deck, 210 ft. Breadth of beam (molded), 33 ft. 6 ins. Depth of hold, 12 ft. 8 ins. Draft of water, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 6 ins.—apart from centres, 16 ins. Her frame is of white oak, chestnut, &c., and very securely fastened with copper and treenails. Tonnage, 860 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 11 feet.

BOILER.—One—Drop flue. Length, 30 ft. Breadth, 10 feet. Height, 10 feet. Has water bottom. Location in hold. No blowers.

PADDLE WHEELS.—Diameter over boards, 21 ft. Material of wood. Number, 18.

Remarks.—This ferry boat is probably the largest of its kind in the world: it certainly will be one of the most capacious and splendid vessels of its class on our rivers, when finished. Her wood work consists of the best quality of oak, locust, and mahogany. She has one independent steam, fire, and bilge pump, and ordinary bilge injections. Contrary to general usage with such boats, her bottom was entirely coppered at the period of launching. It is customary not to copper them until they have been in service about six months. Her aggregate cost will be $60,000. She will take her appropriate position on the Jersey City Line about the first of November.

The Steamer Fire Dart.

Hull built by Thomas Collyer, New York. Machinery in process of construction by the Neptune Iron Works, New York. Owners, Augustine Heard, Jr., & Co., Boston. Commander, Henry W. Johnson. Intended service, coast of China.

HULL.—Length on deck, 200 ft. Breadth of beam (molded), 30 ft. Depth of hold, 11 ft. Do. to spar deck, 11 ft. 3 ins. Draft of water at load line, 5 ft. 6 ins. Floors—molded, 14 ins.—sided, 5 ins.—apart from centres, 26 ins. Her frame is of white oak, &c., and fastened in the most thorough manner. Tonnage, 650 tons. Masts, two—Rig, Schooner.

ENGINES.—Vertical beam. Diameter of cylinder, 46 ins. Length of stroke of piston, 12 feet.

Boilers.—Two—Return flued. Length, 27 feet. Breadth, 9 feet 10 inches. Height, 8 ft. 9 ins.

Paddle Wheels.—Diameter over boards, 28 ft. Length of blades, 8 ft. Depth, 2 ft. Number, 24.

Remarks.—This steamer has been constructed of the best materials and put together in a masterly manner. Her model appears to be without fault. She is furnished with guards similar to a steam-ship, and will be enclosed to the promenade deck. Her value when finished will be about $85,000. Mr. Collyer is erecting other vessels (of which mention will be made below) for parties in Boston and China. This builder seems to have achieved a celebrity in the East somewhat akin to other builders with us. It has not been long since papers published in England contained an account of the performances of a new steamer sent from the Clyde, in contrast with the steamer *Yang-tse*, built by Mr. Collyer, and which had been running in Chinese waters a period of three years; they made the reluctant admission that though the former cost nearly three times as much on the Clyde as the latter did in the United States, she consumed double the amount of coal, and had less capacity for freight and passengers, thereby showing a clear triumph for the American steamer.

The Steamer Primeira.

Hull built by Webb & Bell, Green Point, L. I. Machinery in process of construction by the Novelty Iron Works, New York. Owners, Dr. Raney and others, Rio Janeiro, S. A. Intended service, Bay of Rio Janeiro.

Hull.—Length on deck, 130 ft. Width over guards, 50 ft. Breadth of beam, 28 ft. Depth of hold, 10 feet. Do. to spar deck, 9 ft. 6 ins. Draft of water at load line, 6 ft. Floors—molded, 13 ins.—sided, 9 ins.—apart from centres, 24 ins. Frames very securely fastened. Tonnage, 350 tons.

Engines.—Vertical beam. Diameter of cylinder, 32 ins. Length of stroke of piston, 8 ft. To be of 180 horse-power, calculated to insure a speed of 12 knots per hour.

Boiler.—Drop flue. Length, 21 ft. Breadth, 8 ft. 6 ins. Height, 8 ft. 6 ins.

Paddle Wheels.—Diameter over boards, 16 ft. Length of wheel blades, 6 ft. 8 ins. Depth, 2 ft. Number, 14.

Remarks.—This vessel is most appropriately called the *Primeira* (first), and is one of three which are intended for the use of our southern imperial neighbor, designed for service as above stated. Dr. Raney, a gentleman of great energy and enterprise, after a year of most incessant labor, and encountering the combined opposition of the old Thames boat ferry company and the whole English influence, which has monopolized the steam-ship business in Brazil ever since the introduction of steam power, last winter succeeded in establishing a company for running steamers on the American plan, and obtaining a charter from the government, conferring the right of navigating the Bay of Rio Janeiro for a period of thirty years. As no other steamer has ever been built for that country by American ship-builders, it is

reasonable to hope that this will give such a good account of herself as to secure more business of the same kind for our yards.

This vessel is constructed with extraordinary strength, her materials being principally of white oak. The ceiling and planking are of 2½ inch white oak, with double frames of the same, continuing from stem to stern, and strongly copper fastened. The manner of her whole construction is highly creditable to the skill of Messrs. Webb & Bell, and gives great satisfaction to her owners. The keel of the other two will be laid immediately. Their aggregate cost will be $180,000.

The Clipper Bark, D. Golden Murray.

Hull built by E. Lupton, Green Point, L. I. Owner, D. Golden Murray, City of New York. Commander, Capt. Richard Lee, formerly of the bark *Lucky Star*. Superintendent of construction, J. C. Conner. Intended service, New York to Galveston, Texas.

HULL.—Length of keel, 112 feet. Do. of main deck, 122 feet. Do. over all, 133 ft. Breadth of beam at midship section, 30 feet. Depth of hold, 12 feet 6 ins. Frames of white oak, &c., &c., and thoroughly fastened. Tonnage, 510 tons.

Remarks.—The model of this bark bespeaks speed and excellent carrying abilities. She is capable of bearing 835 tons dead weight, and then will draw but ten feet of water. She has been fitted with all the modern improvements, having double topsail yards and patent reefs in her courses. There are seven vessels now belonging to this line of packets, and it is expected that this, the last addition, will fully sustain their excellent reputation.

THE ABOVE SIX VESSELS HAVE BEEN LAUNCHED WITHIN A VERY BRIEF PERIOD, AND ARE NOW UNDERGOING THE PROCESS OF COMPLETION WITH ALL POSSIBLE DESPATCH.

The following are still on the stocks, or about being commenced:—

At Thomas Collyer's, New York.

A day boat to run between New York and Albany has just been commenced. She is to run with great economy of fuel, and to be of good speed. The subjoined are some of her dimensions:—

HULL.—Length on deck, 250 ft. Breadth of beam (molded), 30 ft. Depth of hold to spar deck, 10 ft. Frames—molded, 15 ins.—sided, 4 ins.—apart from centres, 30 ins. Draft of water, 5 ft. Tonnage, 700 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke of piston, 10 feet.

BOILERS.—Two—Return flued. Length, 29 ft. Breadth, 9 ft. Height, 9 ft. 5 ins. Number of furnaces, two in each.

PADDLE WHEELS.—Diameter over boards, 30 feet. Length of blades, 9 feet. Number of do., 24.

The machinery to be constructed, I understand, by the Neptune Iron Works.

Also, a steamer for Messrs. John W. Forbes & Co., of Boston, Mass., under the superintendence of George N. Sands, is building here. To be named the *Hankow.**

* Since launched.

HULL.—Length on deck, 212 feet. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold, 11 ft. 6 ins. Draft of water at load line, 7 ft. Floors, molded, 14 ins.; sided, 7 ins.; apart from centres, 27½ ins. Tonnage, 750 tons. Two masts, schooner rigged. Machinery to be constructed by the Morgan Iron Works.

ENGINES.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke of piston, 12 feet.

BOILERS.—Two—Return tubular. Length, 20 feet. Breadth, 11 feet. Height, 9 ft. Two furnaces in each boiler.

PADDLE WHEELS.—Diameter over boards, 29 ft. Length of wheel blades, 7 ft. 6 ins. Depth, 2 ft. Number, 26.

This vessel will be made very strong, being iron strapped throughout and well timbered. Materials used, white oak, chestnut, &c. It will cost, when finished, $90,000.

This is the third vessel erected for the China trade for Messrs. Forbes & Co., and three others have been constructed for the Chinese waters; one of which was sold to the French government for a war steamer, and another purchased by the Chinese government for war service, to protect their junks from the depredations of the river pirates who infest their waters. The others are actively employed on the rivers.

Another steamer of smaller dimensions than the above is also in process of construction, for parties in New York, who design placing her in the coasting and river trade in the Chinese Empire.

Her length will be 160 feet. Breadth of beam (molded), 26 ft. Depth of hold, 10 feet. Not yet named. Machinery by the Morgan Iron Works.

In many respects, the details of her construction will be similar to the *Hankow*.

At Henry Steers', Williamsburgh, L. I.

A beautiful side-wheel steamer is being constructed at this place, under the superintendence of Edward N. Dickerson. She is intended to run in conjunction with the Florida Railroad, along the Gulf Coast, between Cedar Keys and New Orleans.

Her dimensions will be as follows:—

Length on deck, 285 feet. Breadth of beam (molded), 37 ft. 6 ins. Depth of hold, 13 feet. Tonnage, 1350 tons.

Another steamer of similar construction will soon be commenced by Mr. Steers.

At Sneden & Rowland's, Green Point, L. I.

A large side-wheel steamer, to run between New York and New Haven, is in process of erection here. Her dimensions will be as follows:—

HULL.—Length on deck, 280 ft. Breadth of beam (molded), 35 ft. Depth of hold, 11 ft. Draft of water, 6 ft. Frames, of white oak, chestnut, and cedar, copper fastened, and diagonally and double laid with iron straps, 3½ by 9-16ths of an inch. Tonnage, 1200 tons.

Engines.—Vertical beam. Diameter of cylinder, 65 inches. Length of stroke of piston, 12 feet.

Boilers.—Two—Return flued.

Paddle Wheels.—Diameter over boards, 28 feet.

The machinery is to be constructed by the Neptune Iron Works, New York.

The erection of two more steam vessels has also been commenced. They are intended for the Norwich and New York Steam Navigation Co., to run in conjunction with the Norwich and Worcester Railroad. Their principal dimensions will be:—

Length on deck, 300 feet. Breadth of beam (molded), 37 ft. 6 ins. Depth of hold, 13 feet. The contract for constructing the machinery has just been completed with the Novelty Iron Works. They will have beam engines, with a cylinder 75 inches in diameter, and stroke of piston of 12 feet. Their tonnage will be 1350 tons each.

The keel of an iron propeller has also been laid. She is building for Pezant Bros. & Co., to run between Mexico and Cuba in the cattle trade. Her dimensions will be:—

Length on deck, 135 feet. Breadth of beam, 22 feet. Depth of hold, 5 feet. She will be supplied with Ericsson's hot-air engine. Tonnage, 300 tons.

This firm will immediately begin an iron steamer for the New Orleans and Mobile mail route. The machinery, I understand, is to be constructed by the Morgan Iron Works. I append her principal dimensions:—

Hull.—Length on deck, 250 feet. Breadth of beam, 34 feet. Depth of hold, 10 feet. Floors—⌉, molded, 3½ ins.—sided, ⅝ths of an inch. Frames—angle iron, 3½×3½×⅝—apart from centres, 18 ins. Five single plates, fore and aft. Keelsons, having four angle bars on each, ⌶. Keel, U, ¾ thick. Tonnage, 650 tons.

Engines.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke of piston, 10 feet.

Boiler.—Return flued.

Paddle Wheels.—Diameter over boards, 30 feet, with a face of 10 feet.

At Lawrence & Foulk's, Williamsburgh, L. I.

They have upon the stocks and nearly completed a steamer for the Spanish Government, intended for towing purposes in the harbor of Havana. Her dimensions are:—

Length on deck, 100 ft. Breadth of beam, 24 ft. Depth of hold, 9 ft. 6 ins. Tonnage, 275 tons.

Machinery—By the Fulton Iron Works.

Engine.—Vertical beam. Diameter of cylinder 30 ins. Length of stroke of piston, 6 feet.

The cost of this boat, when finished, will be $30,000.

At Wm. H. Webb's, New York,

Is now building a magnificent side-wheel steamer for Saml. L. Mitchell's New York and Savannah Line. Her dimensions will be:—

Length on deck, 250 ft. Breadth of beam (molded), 38 ft. Depth of hold, 22 ft. 6 ins. Tonnage, 1750 tons.

These dimensions will make her considerably larger than any vessel on the line, and will increase the number of running ones to four side-wheel steamers and one propeller. Machinery by the Morgan Iron Works.

Mr. Webb is also building a large packet ship for the Black Ball Line. Owners, Charles H. Marshall & Co., City of New York. She will be constructed of white and live oak and locust, and possess two decks. Her dimensions are:—

Length on deck, 278 ft. Breadth of beam, 39 ft. Depth of hold, 23 ft. Tonnage, 2000 tons. Will be completed about the middle of November.

A brig of 270 tons is also building here. Her destination will be the Brazos River.

At S. Allison's, Jersey City.

A steamboat for Roman & Tremper, Kingston, N. Y., is building here. The route of her intended service will be between the City of New York and Kingston, on the North River. Her dimensions are:—

Length on deck, 242 feet. Breadth of beam (molded), 34 ft. 3 ins. Depth of hold, 9 feet. Engine of 56-inch cylinder, and 12 feet stroke of piston.

She will be finished in the course of two months, and will then take the place of the *North America*, which is getting very old.

At Webb & Bell's, Green Point, L. I.,

Is building a fine steamer for the Stonington Line. She will be 272 feet in length, 32 feet beam, and 10 feet depth of hold. The Novelty Iron Works will construct the machinery.

They have also on the stocks a brig of 250 tons, for I. & N. Smith & Co., City of New York, to run between New York and the West Indies. Her dimensions are:—

Length on deck, 117 ft. Breadth of beam, 27 ft. Depth of hold, 8 ft. 6 ins.

Her cost will be $120,000.

At Roosevelt, Joyce & Co.'s, New York.

They have in course of erection at their yard four ferry boats, each of 500 tons burthen. Two are for the Union Ferry Co., and the others for the East River Ferry Co., City of New York. The latter intending to ply between Hunter's Point and New York, in connexion with the Long Island Railroad Company. The former will run between the City of New York and Brooklyn. The machinery of the lot will be supplied by the Allaire Iron Works. The cylinders of the engines will be 34 inches in diameter, with a stroke of piston of 9 ft.

At Novelty Iron Works, New York.

At this place a beautiful iron screw steamer is now building. Owners, H. Cromwell & Co. Intended service, New York to Wilmington, N. C. Her principal dimensions will be:—

Length on deck, 180 ft. Breadth of beam, 25 ft. Depth of hold, 15 ft. Her hull will be of iron, whilst the upper portion will consist of wood, constituting her one of the

staunchest vessels in our waters. Her engine will be of 42 inches diameter of cylinder, with a stroke of piston of 3 ft. 6 ins. Her propeller will be 12 feet in diameter. Tonnage, 650 tons.

These works have also contracted to erect an iron steamer, 100 feet in length, for parties in Carthagena, South America.

Thus, it will be seen by these particulars that no surer or more reliable index of the skill of our mechanics and the prosperity and welfare of our commercial relations can be found, than in the activity of the ship-building trade of the City of New York and its vicinity.

E. B.

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*The Incrustation of Boilers.**

Mr. James R. Napier, ship-builder and engineer, of Glasgow, submitted to the Philosophical Society of that city, on the 18th ult., a very interesting paper on the incrustation of boilers using sea-water, to which we think it desirable to draw particular attention. It appears that on a former occasion Mr. James Napier, chemist, read a paper on the same subject to the Society, in which he made certain suggestions. Feeling much interested in these suggestions, Mr. James R. Napier put them to trial on board the Islesman, on a voyage to the north of Scotland in 1858, in order, if possible, to see the effect. On this occasion, we are told, half a pound of dissolved soda ash was forced into the boiler along with the feed-water at 9h. 30m.; at 11h. 30m. another half pound was forced in; at 3h. 30m. one pound was forced in; and at other times, more was put in. The only effect observed by these operations was making the water in the gauge glass of a milky appearance within a few minutes after the soda was introduced; it continued so for probably an hour after each injection, a small pipe near the surface of the water allowing a continuous discharge from the boiler.

The experiments showed that if the system proved economical, a simple plan could easily be arranged for carrying it out. But as Mr. Napier, in his paper, states "that this sort of crust (sulphate of lime) cannot be avoided by care or mechanical means, except by keeping the salt in the water under its crystallizing quantity, which would necessitate such an amount of blowing off and supply as would render it expensive," the expense of both methods was calculated—the chemical one of neutralizing the sulphate of lime with soda, and the mechanical one of an abundant discharge and supply, so as to keep the sulphate of lime under its crystallizing quantity. It is necessary for this purpose to know the relative proportions of feed-water, and water required to be discharged, in order to prevent scale or crust. Many writers treat this crust, says Mr. J. R. Napier, as if it were common salt, and instruct persons how to make and graduate instruments for ascertaining its quantity, the graduations being effected by observing

* From the London Mechanics' Magazine, Feb., 1860.

the depths to which the instrument sinks in water in which certain proportions of common salt has been dissolved. They say, sea-water contains 3 per cent. of salt, and when the boiler contains less than 12 per cent. there will be little or no crust; therefore it is necessary to blow off 3-12ths or 1-4th of the feed-water, in order to prevent the formation of crust. This reasoning, however, as Mr. Napier remarks, is unsatisfactory; as it is evident to any one who has the sense of taste, that the crust is not common salt; and chemical analysis shows that sea-water from the English Channel, although it contains nearly 3 per cent. of common salt, contains only about 0·8 per cent. of the materials forming the crust, and only 0·14 per cent. of the material of which, according to Mr. Napier, chemist, upwards of 90 per cent. of the crust is composed. It is also shown by analysis that a saturated solution of this material (sulphate of lime) in cold distilled water, is as 1 to 380, and as 1 to 388 in boiling water, or 25·7 parts of lime to 10,000 of solution. Mr. Napier, however, found 203 grains of sulphate of lime per gallon in water taken from a boiler off Ailsa Craig. Its density is not stated; but assuming it to contain twice its natural quantity of saline matter, or its density to be 1·0548, sea water being 1·0274,—this gives the ratio 203 to 73,836, or 1 of sulphate of lime to 364 of solution, or 27·47 of sulphate of lime to 10,000 of solution. This proportion, it is inferred, is either a saturated solution, or such as the engineer of the vessel found little or no crust formed in. For want of better data, 28 of sulphate of lime to 10,000 of solution is assumed as the limit of saturation in boilers using sea-water, working at pressures not exceeding 20 lbs. above the atmosphere. This is equivalent to discharging 14-28ths, or one-half of the feed-water. This assumption is confirmed by the practice of the British and North American Mail Company; by Mr. Napier's Ailsa Craig engineer, who was evidently blowing off nearly this amount; and by an experiment of Mr. Thomas Rowan, of Glasgow, made for the purpose of ascertaining when the sulphate of lime and when the common salt deposited. He found, when he

evaporated	2-10ths	of the water, a trace of sulphate of lime deposited.
"	4-10ths,	ditto, ditto.
"	5-10ths,	the sulphate of lime began to deposit in larger quantities.
"	6-10ths,	ditto, decided quantities.
"	8-10ths,	sulphate of lime deposited in very large quantities; also magnesia and salt began to form.

"Mr. Rowan's experiment," says Mr. J. R. Napier, "although indefinite as to the quantities, shows that the sulphate of lime begins to deposit before even one-half of the water is evaporated. It is probable, therefore, that this quantity, or more, would require to be discharged in order to prevent the formation of crust in boilers."

A saturated solution of common salt in distilled water is given as 27 of salt to 100 of solution; and a saturated solution in sea-water is

said to be 36 of salt to 100 of solution. The former ratio has been chosen for comparison in this case, so that 27-270ths, or only 1-10th, of the feed-water would require to be discharged in order to prevent the formation of common salt, and 8-10ths to be neutralized by soda to prevent the deposit of sulphate of lime, the 1-10th discharged being a saturated solution of sulphate of lime and common salt. It is thus shown, that by the chemical method it is necessary to discharge 1-10th of the feed-water, and neutralize the sulphate of lime in 8-10ths of it with soda, according to Mr. Napier's method, to prevent crust; and by the mechanical method, it is necessary to discharge 5-10ths. The quantity of soda ash (supposed to contain 50 per cent. soda) is found by the formula $\frac{62}{68}$ of $\frac{14}{10000}$ of $\frac{8}{10}$ of feed-water.

For the purpose of illustrating the expense of both methods of preventing crust, and also the loss by the blowing-off method, the case of a vessel has been taken by Mr. J. R. Napier, working at a temperature of 270°, and evaporating at that temperature $7\frac{1}{2}$ ℔s. of water from 100° per ℔. of coal.

		Chemical Method.
Sea-water supplied to boiler, temp. 100°,	15·0 lbs.	8·33 lbs.
Water discharged, 270°,	7·5 "	0·83 "
Water evaporated,	7·5 "	7·5 "
Total heat evaporating from 100° at 270° $h_{1\cdot 2}$ $= 1092 + 3\text{-}10\,(T_1 - 32) - (T_2 - 32)$ $= 1095\cdot$	8215°·5	8215°·5
Heat discharged,	1275°	142°
Fuel consumed in evaporation,	1·0 "	1·0 " coal.
Fuel consumed in preventing crust,	0·155 lbs. coal,	0·0172 lbs. coal + 0·0085 lbs. soda ash.
Total fuel,	1·155 lbs. coal,	1·017 lbs. coal + 0·0085 lbs. soda ash.

Thus, it is seen that it requires only 172 ℔s. coal + 85 ℔s. soda ash, containing 50 per cent. soda, to be as efficient in preventing crust as 1550 ℔s. of coal alone, which evaporates $7\frac{1}{2}$ ℔s. water from 100° at 270°. And these methods are equally expensive when the soda ash is 16·2 times dearer than the coal. This ratio varies with the efficiency of the fuel and the temperature of evaporation.

Although when coals are 10*s.* and soda ash £10, Mr. Napier's method is more expensive than the ordinary one of discharging the saturated water, there are many cases where it is probable the owners of vessels would profit by its adoption. In long voyages, for example, a vessel requiring by the ordinary mode 1155 tons of coal, would by Mr. Napier's method require, as Mr. J. R. Napier remarks, 1017 tons coal, and $8\frac{1}{2}$ tons soda ash, or $1025\frac{1}{2}$ tons weight. There would be a saving in money, therefore, of 138 tons coal, 129 tons of freight, and $8\frac{1}{2}$ tons of soda ash; or if coals are 10*s.* per ton, freight £8, and soda ash £11 per ton, the saving would be £362. That boilers, however, can be worked till the water in them is nearly saturated with common salt, or that the soda ash can be so accurately proportioned as *exactly* to neutralize the sulphate of lime, are problems which are believed to be new, and have not yet been attempted. The considerable saving which may be effected, shows that the method is worthy of a trial.

We quote the following remarks from the conclusion of Mr. J. R. Napier's paper:—

"From the foregoing example," he says, "of a vessel worked at a temperature of 270°, it is also seen that a quantity of fuel, equal to 15½ per cent. of that which produces evaporation, is consumed by the ordinary blowing-off method, in order to prevent crust, and this amount increases with the temperature. Brine chests have been frequently used for the recovery of this notable loss; but apparently from a misapprehension of the quantity of water necessary to be discharged, and a want of knowledge of the amount of surface required to absorb the discharged heat, of a capacity greatly too small for their purpose. If Peclet's formula for calculating this surface is to be trusted, those chests on board the West India mail steamship *La Plata*, and some of the British and North American Company's packets, are 1-15th to 1-20th of the size that would be efficient. When these brine chests, regenerators, or heat economizers, therefore, are made with a *sufficient* amount of surface, so that abundance of water can be supplied to and discharged from the boilers with little loss of heat, then there will be no incrustation of boilers, and a probable saving of from 12 to 13 per cent. of their fuel. Peclet's formula, or Professor Rankine's reduction of it, which gives the probable amount of surface required for a difference of temperature of 140° between the feed and the discharged water, at 1-10th square foot per ℔. of brine discharged per hour, becomes under the same circumstances, and when the quantity of brine discharged is equal to the quantity of water evaporated, 1-10th square foot of surface per ℔. of water *evaporated* per hour. The introduction of Dr. Joule's spiral wires to the system will probably render less surface efficient. This amount of discharge and surface, it is expected, will prevent incrustation, and save nine-tenths of the heat at present lost."

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*On the Construction of Artillery and other Vessels to resist great internal pressure.** By J. A. Longridge, M. Inst. C. E.

It was stated in the outset, that it was not proposed to treat of the very wide range of subjects involved in the construction of the most perfect description of ordnance, but to limit the inquiry to the question, how to make a gun of sufficient strength to enable the artillerist to obtain the full effect of the explosive compound used in it? This question was one which the civil engineer was probably more fitted to deal with than the artillery officer, inasmuch as it required nothing beyond a knowledge of the properties and laws of action of those materials with which his every-day practice made him familiar.

The attention of the author was drawn to the subject early in the year 1855. Following up the reasoning of Prof. Barlow on hydraulic press cylinders, he was led to consider how the internal defect of any homogeneous cylinder could be remedied. Prof. Barlow had shown, that in every such cylinder the increase of strength was not in pro-

* From the Lond. Civ. Eng. and Arch. Journal, Mar., 1860.

portion to the increase of thickness, and that a vessel of infinite thickness could not ultimately resist an internal pressure greater than the tensile forces of the material of which it was composed. The material at the internal circumference might, in fact, be strained to its utmost, when that at the outside was scarcely strained at all. To remedy this, it was necessary that each concentric layer of the gun or cylinder should be in an initial state of stress, such that when the pressure was applied, the sum of the initial and the induced stresses should be a constant quantity throughout the whole thickness of the cylinder. It occurred to the author that this could be accomplished by forming the gun or cylinder of a thin internal shell or case, and coiling round it successive series of wires, each coil being laid on with the tension due to its position.

The principle of building up a gun in successive layers, with increasing initial tension, was, therefore, that which it was intended to bring forward in this paper. The author claimed no exclusive merit for this idea. Although then unknown to him, it was being followed up by Capt. Blakely, Mr. Mallet, and others, who, however, sought for its practical outcome in rings or hoops, contracted or forced on to the central core. Capt. Blakely had, equally with the author, the idea of making use of wire, although his experiments were entirely confined to hoops. It was in complete ignorance of what others were doing that the author undertook the experiments recorded and described in detail in the present paper. The results were so striking, that he lost no time in bringing them before the War Department. The usual reference was made to the Select Committee at Woolwich, with the usual result. The principle was pronounced to be defective, and not such as to warrant any trials at the public expense. The author, however, continued his experiments, and the results were such as entirely to confirm his confidence in the practical utility of the invention.

Before describing these experiments, the paper referred to the construction of guns as hitherto practised. It was first shown, from the author's experiments, that the strength of powder was about 17 tons per square inch. The system of rifling, involving elongated shots without windage, greatly increased the strain on the gun. This being so, it was not surprising that many attempts to rifle the ordinary guns had proved fruitless. Even independent of this extra strain, experience had shown that for heavy ordnance, cast iron was too weak; and it was believed that this was not owing, as had been stated, to any deterioration in the quality of the material, or to any want of honesty on the part of the contractors, but simply to more work being put upon cast iron than it would bear.

Experiments on the direct tensile force of cast iron must not be depended upon, when the material was cast in a huge mass like that of a 68-℔. gun or a 13-inch mortar. Neither could such experiments be trusted as regarded wrought iron or steel. It was shown that the iron cut from the inner part of the Princeton gun was 50 per cent. weaker, as strained by the explosion, than the bar iron from which it was made. The same decrease of strength, though to a less extent,

was found in the case of the great gun forged by the Mersey Iron Company, and presented by them to the country. Moreover, large masses of any metallic substance must always, it was believed, be subject to inequalities of physical structure, which rendered them untrustworthy for heavy ordnance.

These considerations led the author and others to the principle of construction already named. Capt. Blakely and Mr. Mallet sought to apply it by means of hoops, which, under almost any circumstances, gave an increase of strength. If correctly applied, this increase was very considerable, but there were great difficulties in the application. Each hoop was itself subject to the same law as a homogeneous cylinder, and consequently a series of hoops was wanting in that uniformity of strain which was required. It was possible so to adjust the hoops that at the time of explosion the inner surface of each might be equally strained, but the strain on each hoop decreased to the outer surface, so that there was an abrupt change at the junction of any two hoops. Moreover, a very slight error in workmanship would produce a most serious effect. Taking, for instance, an 8-inch gun, constructed of four concentric hoops, the total thickness being $6\frac{1}{2}$ inches, an error of $\frac{1}{500}$-inch in the size of the outer ring would reduce its strength by 43 per cent.

Wire, on the other hand, afforded the greatest possible facility of construction, and the coils might be laid on with the utmost accuracy as regarded tension, and with the same ease and regularity as thread was wound on to a bobbin.

The first series of experiments tried by the author were made with brass cylinders, 1 inch internal diameter and 1-10th inch thick. Into these, various charges of powder were put, and the ends hermetically sealed. The total capacity of these cylinders was 295 grains of powder. One of these cylinders was burst with a charge of 90 grains. Another, exactly similar, but covered with four coils of 1-33 inch steel wire, was uninjured by a charge of 200 grains.

It having been objected, that owing to the brittleness of cast iron it would be impossible to use it in conjunction with wire, cylinders of cast iron of the same size were prepared. Some of them were entirely filled with powder (310 grains), which was then exploded without injury to the cylinder. In this case, the cylinders, which were 1-10th inch thick, were bound round with ten coils of iron wire, No. 21 gauge, or 1-28th inch diameter. The bursting charge, without wire, was 80 grains.

After this, a small gun was made of cast iron, covered with wire. The chase was 3 feet long, and the calibre 3 inches. The cast iron at the breech was $\frac{5}{8}$-inch thick, and decreased to $\frac{3}{8}$-inch at the muzzle. Iron wire 1-16th inch diameter was used, there being twelve coils at the breech, and four coils at the muzzle. The total weight of the gun with its wrought iron trunnion stock, was 8 cwt. With this gun, and an elongated shot weighing $7\frac{1}{2}$ lbs., and with 11 oz. of government cannon powder, a range of upwards of 1500 yards was attained, the elevation being 7°.

Another application of the principle was stated to be to the cylinders of hydraulic presses, and an instance was given of a cylinder of 6 inches internal diameter, made of cast iron ⅜-inch thick, and covered with twelve coils of 1-16th inch iron wire. This cylinder was proved up to 6 tons per square inch, when it gave way by the sides shearing off the bottom plate. The cast iron was not shattered, nor was a single coil of the wire injured.

It was stated that these cylinders could be made at one-fourth the weight and at about one-half the cost of the ordinary hydraulic press cylinders; and that their lightness was of great importance when intended for export to South America and other countries where the means of transport for heavy machinery did not exist.

Translated for the Journal of the Franklin Institute.

Methods employed by the Ancients to Move, Haul, or Raise Blocks of unusual Dimensions. Translated by J. BENNETT, C.E.

From Rondelet's "Art of Building."

The immense ruins of the ancient edifices of Egypt bear witness to the taste which the Egyptians had for the grand and durable; the blocks used for their constructions were of enormous size. Herodotus speaks of an edifice which formed a part of the temple of Latona at Buto, whose walls were formed of a single rock 52·8 feet long by as much in height. The ceiling or covering of this edifice was also a single block with 5·28 feet thickness.

In another place he says that Amasis ordered to be transported from the Isle of Eléphantine to the town of Sais, twenty days sail distant, a structure formed of a single block of stone; its exterior length was 27·72 feet by 18·48 wide and 10·56 feet high. The interior measured 24·86 feet in length, by 15·84 in breadth, by 6·6 in height. Two thousand men were employed three years in its transportation.

The mass of this last structure, deducting the empty space within, was 2822 cubic feet, and its weight was 458,744 lbs., on the supposition that the rock was formed of the same granite as the obelisks.

As for the other structure which formed a part of the temple of Latona at Buto, the Greek text of Herodotus seems to describe the four walls as being formed of a single block *hollowed like a trough.* In this case it would have required a block of 147,200 cubic feet, with a weight of 24,260,500 lbs., and supposing it was not transported until after being hollowed, its weight would still have been 9,944,750 lbs.

The transportation of so heavy a mass and of so great volume would appear as an inconceivable difficulty, even by water, on account of the immense size of the vessel or platform required to keep afloat so great a load, which was twenty times that transported by Amasis. The difficulties of unloading and moving upon the ground so great a mass would seem to be insurmountable, as it would not be possible to find machines or rollers strong enough to bear such a weight without crushing. The Count of Carbury, who had charge of the transportation of the rock to St. Petersburg, whose weight was only 3,234,000 lbs.,

said that it was impossible for him to make use of rollers; even iron ones were insufficient. Balls of wrought and cast iron, which he tried to substitute for them, were flattened and broken, as well as the cushions of the same metal, in which these balls rolled; only those made of a mixture of copper, tin, and calamine could resist the pressure. Still, as we cannot contradict a matter which Herodotus says he saw and regarded with wonder, we must believe that the walls of this structure were hollowed out of a mass of rock found upon the spot. *This conjecture is all the more probable, as Herodotus does not mention where this enormous block came from, nor the mode of its transportation.*

As for the stone which formed the upper part of the structure, it is evident that it must have been taken from another block, and that it must have been moved and raised above the walls. It was 52·8 feet long by as many broad, with a depth of 5·28 feet, making, all trimmed, a mass of 14,720 cubic feet, and a weight of 1,984,950 lbs., supposing the stone to be of a mean hardness with that used for most of the temples and for the steps of the pyramids.

A block of such dimensions must have been moved in the same position it was to have when laid. The operation required a plane and solid surface of great extent; and as wood was scarce in Egypt, we may presume, according to what Herodotus said in relation to the great pyramid of Cheops, that in these extraordinary circumstances the custom of the Egyptians was to construct large causeways and inclined planes of cut stone, upon which they hauled the enormous stones which they prided themselves on using for the construction of their edifices. These means, which would be expensive with us, were but a small matter with them, by reason of the great number of men employed upon their works, and the small wages of the laborers, and the insignificant cost of the materials.

When they had to move round and unwrought masses of granite, such as are found in the quarries of Egypt, they were turned over or rolled by the force of men. In many places far distant from the quarries, are found masses of granite whose transportation appears to have been interrupted by some unforeseen causes.

As for the blocks which do not come in this kind of transportation, and whose surfaces were plane, as that which served for the covering of the temple at Buto and the monolithe structure of Amasis, we believe that they made use of rollers and capstans, the most simple and ancient machines, the most powerful and speedy in their effects. To give our ideas upon this, we report the result of an experiment made upon this subject with a cut stone weighing 1165 lbs.

To drag this stone upon a horizontal surface of the same material and coarsely cut required 818 lbs.

The same drawn upon pieces of wood exacted a force of 703 lbs.

The same placed upon a wood platform and drawn upon wood required a force of 654 lbs. But soaping the two surfaces which slid upon each other, there was only needed 196 lbs.

This stone, put upon rollers 3·2 inches diameter and set in motion

upon a surface of the same material, required only a force of 36·68 lbs.; the same rolling upon pieces of wood yielded to an effort of 30 lbs., and when the rollers were put between two pieces of wood $23\frac{3}{4}$ lbs. sufficed.

It follows from this experiment that to draw a rough stone upon a firm and smooth bottom, there is needed a little over $\frac{2}{3}$ of its weight; the $\frac{3}{5}$, if the surface is of wood; $\frac{5}{9}$, if the movement is made of wood upon wood; and if the two sliding surfaces of wood are soaped, but $\frac{1}{6}$. But if we use rollers placed immediately between the stone and ground there will be required a little over $\frac{1}{32}$ of the weight, and $\frac{1}{40}$ if they roll upon wood; and finally, if they roll between two smooth wooden surfaces there will be needed but about the $\frac{1}{50}$ of the weight.

Still it is proper to remark, that as woods compress under great loads, the rollers made of this material are subject to a change of form, to be crushed, and to sinking in the pieces between which they are placed; this produces a friction, whose effect increases with the load. To raise the obelisk at the square of St. Peter's in Rome, which, with all its fixtures, weighed 829,250 lbs., there were required forty capstans, and to draw it upon a horizontal plane with rollers placed between two wooden surfaces it only needed four; whence it follows in this case that the force was but the $\frac{1}{10}$ part of the weight, while the experiment above cited gives a little over the $\frac{1}{50}$ part. But Fontana, who superintended this operation, observed that most of the rollers, which were 70 in number, were crushed, and that the others sank into the pieces of wood between which they were placed.

To have the full benefit of the rollers they should be as incompressible as the surfaces between which they move. Granite rollers between surfaces of the same material to prevent breaking should be very short, and their number great, to have as little of the load as possible on each. The length should not be over one-and-a-half diameters. When the stone has considerable width they must be set in many rows. This method, if practicable, would have been preferable to the balls, which the Count of Carbury used for the transportation of the rock which served for the base of the equestrian statue of Peter the Great; they required the $\frac{1}{22}$ part of the weight.

From the results of these experiments and the observations to which they give rise, we may calculate the force required to transport the stone which formed the monolithe structure at Saïs, and the covering of the temple at Buto.

Experience with works has taught us that a man of medium strength and used to work like those employed by the ancients can carry a load equal to his weight and haul one-and-a-half times as much, so that for the stone cover of the temple at Buto, whose weight we have estimated at 1,984,950 lbs., there would be required 10,000 men to draw it upon a smooth and solid ground; 9000 to draw it upon a surface formed of pieces of wood; 8333 if the stone was put upon a wood platform and drawn upon wood; and only 2500 men if care was taken to soap the two surfaces which slid upon each other.

The block being 52·8 feet wide, the men could easily be disposed in

forty rows, which for the first case would require 250 in each row, in case they were equal, and much less if they diverged; 225 for the second; 208 for the third; and 62½ for the fourth; the last is the most practicable method.

The great breadth of this stone and its weight would make it impossible to use wooden rollers. As for those of granite, if the ground were firm and smooth enough to make use of them, 300 men or 7½ rows would have sufficed to move the load. But it is not likely that this method was adopted on account of its great expense. It is much more probable that they made use of capstans.

Supposing a simple capstan, traversed by two levers with a mean length at the point of application of the resultant force of ten times the diameter of the drum, each man makes an effort which may be valued at at 539½ lbs. If twelve men work each capstan, their effort will be 6474 lbs., which gives in the first case, when a force equal to ⅔ of load is required, 2400 men and 200 capstans.

For the second case 2160 men and 180 capstans; for the third 2000 men and 166 capstans; and for the fourth 600 men and 50 capstans.

By the use of pulleys and muffles the number of men and capstans may be reduced one-half or a quarter.

The results here shown indicate the force necessary to move the block upon a horizontal plane; but as it had to be raised above the walls of the temple which it served to cover, in raising it upon an inclined plane it is evident that the force must be increased in the ratio of its inclination. We here give upon this subject some experiments which will serve to make known the proportion of the increase of the force.

If we place a square based solid upon a right plane and the surfaces are not polished, more or less difficulty is experienced in moving it, according to the roughness of the surfaces. But if, instead of pushing the body for its motion, we incline the plane until it commences sliding, we find that it requires as much force to move a round body up this incline as to draw the square based solid upon a horizontal plane. Moreover, to haul up the square based solid upon an inclined plane, we must use a force equal to that which would cause a round body to rise upon an inclined plane as many degrees above the plane on which the square based solid began to slide, as the first plane is above the horizontal.

The force required to raise a round body upon an incline is very nearly the same as that given by theory; whence it follows if we take for the horizontal plane, that upon which a plane surface solid begins to slide, we shall have the force necessary to raise this solid upon any incline by adding to its inclination that of the plane taken for the horizontal.

EXPERIMENTS.—To draw upon a lias slab placed horizontally a cube of the same material, with a face of 4·26 inches weighing 6·74 lbs., it required a force of 3·57 lbs. This cube did not begin to slide until the plane on which it stood was raised a little more than 30°. To

draw up this plane a round body of the same weight and material required 3·52 lbs; the diameter of the body was 4·8 inches.

To draw the above cube upon the same plane inclined 30°, the line of traction being parallel to plane, required a force of 5·95 lbs. This force is sufficient to raise the round body upon a plane inclined 60°.

The force required to raise a round body upon inclines of 30° and 60° is very nearly equal to that given by the application of the principles of mechanics. For, in the first case, theory gives 3·37 lbs. and experiment 3·52.

For the second case theory gives 5·87 lbs., and *experiment* 5·95 lbs.

It follows from these experiments that in taking for the horizontal plane, that upon which a solid with a plane surface begins to slide, we shall find the force required to raise this solid upon any incline, by adding to the inclination of this plane, that of the plane upon which the solid begins to slide. Thus, to make an application of this rule to the great block of Buto, we will suppose the plane for carrying it above the walls was inclined at 12°. This granted, mechanics demonstrates that the force required to raise a round body upon an inclined plane is to its weight, as the height of the plane is to its length; we have found that to draw this stone upon a horizontal plane, in the first case, the necessary force was $\frac{2}{3}$ of the weight; that is to say, it answers to that required to raise a round body upon a plane of 41° 48′, to which adding the 12°, for the slope of plane on which the block is to be raised, we have 53° 48′, whose sine indicates $\frac{4}{5}$ of the weight in place of $\frac{2}{3}$.

In the second case, the force, being $\frac{3}{5}$ of the weight, answers to the sine of 36° 53′, to which adding 12°, we have 48° 53′, whose sine indicates $\frac{3}{4}$ of the weight.

For the third case, the force is $\frac{5}{9}$ of the weight, which answers to sine of 33° 45′, and of 45° 45′ in adding the 12°, whose sine indicates $\frac{7}{10}$ of the weight.

Finally, the fourth case, which exacts but $\frac{1}{6}$ of the weight, answers to the sine of 9° 36′, to which adding the 12° we have 21° 36′, whose sine indicates a force equal to $\frac{9}{25}$ of weight. Thus, by using simple capstans without muffles, there was required, in the first case, to raise the block upon an incline of 12°, 240 capstans and 2880 men.

For the second case, 225 capstans and 2700 men. For the third case, 210 capstans and 2520 men. For the fourth case, 108 capstans and 1296 men.

Making the same applications to the monolithe structure of Amasis, whose weight was 458,744 lbs., we shall find that to draw it without capstans upon a horizontal plane like that of the first case required 2444 men.

For the second case 2200 men; for the third 2037; and for the fourth 611. The description of Herodotus proves that the third method was adopted for transporting this edifice, and that no use was made of rollers or capstans. It appears that the structure was placed upon a platform of carpentry, and drawn upon pieces of wood. The same method was probably used for transporting the obelisk of Rhamesses, spoken of by Pliny, for which 20,000 men were employed. This obe-

lisk weighed 1,618,500 lbs., including its fixtures and the armatures of carpentry required from its great weight to prevent fracture. This process would require more than 7000 men without taking account of those occupied in preparing the roads and machines, which together might require a working force of 10,000 men, and a like number for a relay.

MECHANICS, PHYSICS, AND CHEMISTRY.

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*On the Construction and Durability of Steam Boilers.** By Mr. Benjamin Goodfellow, of Hyde.

The object of this paper is to communicate some circumstances and changes that have been observed by the writer to take place in the size and form of boilers at different temperatures, which affect considerably their strength and durability, by causing derangement and wear and tear to a much greater extent than he believes is generally supposed. His attention was first strongly drawn to this subject some years ago in reference to a large multitubular boiler that he constructed, 23 feet long and 6½ feet diameter, with 131 tubes, 11 feet long and 3 inches diameter each; and two similar boilers, but of smaller dimensions, with 9 feet tubes. A short time after these had been put to work, it was found that several of the tubes began to leak at both ends, although they had previously been proved up to 120 lbs. per square inch with water pressure, when all was good and tight, and the steam pressure they worked at was only from 50 to 55 lbs. After this leakage had been made good, it took place again in a few weeks; and this was repeated several times, both in the large and small boilers, but not to the same extent in the small ones. This led the writer to conclude that the cause was the elongation of the tubes by their being heated to a greater extent than the casing of the boiler; and this defect appears to him a serious objection in multitubular boilers with straight tubes of considerable length.

In the construction of fluid boilers of considerable length, say from 20 to 36 feet long, the writer at first adopted the plan of increasing the diameter of the flue, so as to increase the heating surface and diminish the quantity of water; bringing the flues nearer to each other, in the case of the two-flued boiler, and closer to the sides of the boiler, by making their diameter as large as could be got in. After a number of these had been got to work, several of them gave way transversely about the middle seam at the bottom, especially in cases where the boiler had been blown off for cleaning and cold water then turned in to cool it; the effect of which was that the bottom of the boiler instantly contracted in length, while the flues retained the same length, or nearly so, as when working, until the water came in contact with them, thereby necessarily throwing a great and undue strain upon every seam of the boiler, especially on the lower side, in consequence

* From Newton's London Journal, August, 1860.

of the flues being so near the bottom of the boiler. The writer therefore concluded that it was wrong to increase the diameter of the ends of the flues, as this rendered the ends of the boiler much more rigid and less yielding to the expansion and contraction of the flues and casing, which do not take place in both simultaneously or to the same extent. In a boiler 30 feet long, the actual expansion of the barrel of the boiler amounts to nearly 1 inch in length; and when fired in the flue, the latter is elongated ¼ inch more than the casing, in consequence of its being at so much higher a temperature. The evil effects of this expansion and contraction are further augmented by the ordinary use of gusset stays, by which the ends of the boiler are stiffened and rigidly connected to the barrel. The circumstance of the boilers giving way in the middle of their length rather than in any other part, was owing, in the writer's opinion, to their being supported on a longitudinal centre wall, which divided the flues, or on two walls; when full of water, the boiler would weigh from 38 to 40 tons, and consequently there would be a great friction on the wall when the boiler was contracting; and the strain thus produced in pulling the two ends of the boiler nearer together is concentrated at the middle of its length, in addition to the strain arising from the resistance occasioned by the rigidity of the flues and gusset stays.

In order to obviate these difficulties in flued boilers, and to provide for expansion and contraction taking place without much injury to the material or workmanship, the writer has been led to adopt flues with tapered ends, which give a greater amount of elasticity to the ends of the boiler; and with the same view, the gusset stays are dispensed with, so that the ends are not connected in any way with the casing, except by an angle-iron ring that unites the two together. The same plan may be carried out in a single-flued boiler, either by tapering the ends of the flue, or placing it nearer the centre of the boiler. The ends of the boiler are strengthened independently by means of T iron or "fish-back" girders riveted on each end between the casing and the flues; and there are no longitudinal stays between the two ends beyond those supplied by the flues and casing, each end plate being treated as an independent transverse girder supported round its edge. In order to strengthen the bottom of the boiler at the middle, against the strain produced in contracting by the friction of the longitudinal walls on which it is supported, two longitudinal strips of angle-iron or T iron are riveted on the inside, at about 3 feet apart, extending about two-thirds the length of the boiler. The writer has also adopted for some time a plan of strengthening flues of large diameter against collapse, by means of rings of T iron or angle-iron, riveted at suitable intervals round the outside of the flue at the joints. In these joints the two ends of the boiler plates are not brought together, but are left with a space between them equal to the thickness of the outer rib of the T iron, whereby a joint is obtained having no greater thickness of metal than a double plate at any part.

The absence of longitudinal and gusset stays in this construction of

boiler does not leave the ends less strong to resist explosion than the other parts of the casing: for taking the whole circumference of both flues and casing, the sectional area of plate resisting the pressure on the ends of the boiler is $4\frac{3}{4}$ times greater than that resisting the lateral pressure in the casing; and in the upper half of the ends, where the pressure acts upon the greatest proportionate area, producing the greatest longitudinal tension, the resistance is $3\frac{1}{2}$ times that offered to lateral explosion; while in the lower half of the ends, where there is the least proportionate area for the pressure to act upon, the resistance is $6\frac{1}{2}$ times greater than the lateral resistance. The fact that flued boilers generally explode endways by failure of the lower part of the ends or casing—the very part which has been seen to be originally the strongest—proves that the strength of the plates at that part becomes greatly injured by the excessive strains arising from unequal expansion and contraction of the flues and the casing of the boiler.

Mr. R. B. Longridge could confirm the observations made in the paper as to the frequent injury caused to boilers by the effects of unequal strains upon different portions; but he did not agree with the opinion expressed that the construction of boiler proposed would be free from this source of injury. There was no doubt that great mischief arose in many boilers from imperfect circulation of the water. If perfect circulation could be obtained, a uniform temperature throughout the boiler would be preserved, and these evils obviated. In two-flued boilers, generally, it was a great defect that the water spaces were made exceedingly small, and the descent of the water past them was opposed by the rising current from the heated sides of the flues; so that the only place where the water could descend was at the back end, where coolest; and in a boiler of 30 feet length this downward current was not able to reach the front end. Plates had been put into the boiler sometimes, to divert the currents of water, and cause more regularity of circulation, but he doubted whether with much success. When a couple of 3 feet flues were put into a 7 feet boiler, 3 inch water spaces only could be obtained; and although there was no doubt a better combustion in a large flue, yet this involved the sacrifice of the proper width of water space for insuring due circulation in the boiler, which was a point of greater importance.

He did not agree with the mode proposed for staying boilers, and did not think it was at all advisable to dispense with both longitudinal and gusset stays; he considered that the end should not be left dependent only upon the riveting to the cylindrical shell and the flues. The girder ends of the boiler would no doubt be strong enough so long as the flues held good; but if the flues got seriously overheated at any part and fracture ensued, which was an accident that could not be absolutely guarded against, the boiler end might then give way on losing the support of the flues. In the case of boilers set upon a centre bearing wall, he did not see how the friction upon the bearing could cause such strain in expanding and contracting as sensibly to

affect the durability of the plates; but the best plan of setting such boilers he considered was to support them upon cast iron saddles, in such a manner as not to be dependent for support on the brickwork forming the flues. An objectionable action was caused when the fire was not placed in the boiler flues, but below the boiler, for in that case there was a continued current rising at the sides, causing a descending current in the middle between the two flues, which made the deposit all accumulate in the triangular space between the flues and immediately over the fire: in many such cases, the plates over the fire became overheated in consequence, and fractured or strained at the joints.

Mr. Goodfellow considered the mode of fixing boilers on cast iron saddles was very good, and preferred it where a centre wall was not required for division between the flues. In respect of securing the boiler ends, he remembered a case where the end plates were increased from $\frac{1}{2}$ to $\frac{5}{8}$ inch thickness, on account of the boiler leaking at the ends; but the bottom had then torn asunder, and he had suggested tapering the ends of the flues to a smaller diameter, so as to increase the area of flat plate at the boiler end, and substituting a thinner plate, for the purpose of getting more elastic action in the end plate; this had entirely removed the difficulty, and the boiler had continued at work for $1\frac{1}{2}$ years since then, without any failure. He had found, by carefully measuring the end of a two-flued boiler, 28 feet long, that the front end plate was pushed outwards $\frac{1}{8}$ inch in the centre, making it convex, each time the steam was up, and it gradually came back again on the boiler cooling; the back end of the boiler was not accessible for measurement, being within the brickwork, but both ends must have sprung nearly alike in order to cause the bulging, making altogether $\frac{1}{4}$ inch alternation in length of the flue, constantly going on in the working of the boiler. It appeared to him, then, that as this action could not be prevented, it was the best course to allow the end plates to yield to it, by leaving them elastic, and not hindering them from springing.

Mr. H. W. Harman said, that from his experience as chief inspector to the Manchester Association for the prevention of boiler explosions, he knew of no better construction than the cylindrical two-flued boiler, which was the one in most general use; but it was undoubtedly subject to the derangements pointed out in the paper, from the effects of unequal expansion and contraction. An unequal strain was caused upon the end angle-iron of the boiler from the flues being attached to the end plate so much below the centre; he had found many fractures of the end plates immediately over the angle-irons of the internal flues, caused principally by the end plates not yielding sufficiently to the elongation of the flues. There was no doubt that, if the plate were held too rigidly by gusset stays, something would have to give way to the inevitable strain from expansion; but he could not agree at all with the plan proposed of dispensing altogether with gusset and longitudinal stays. The entire omission of stays would be the opposite extreme, and he thought they ought not to be abandoned without

substituting something else; the angle-iron which would then form the only tie between the end plate and shell, was unavoidably a comparatively weak form of iron from the mode of its rolling, and he feared, if such a plan were adopted, great risk of accident from inferior quality of angle-iron would ensue. He had examined boilers that had exploded, in which the whole of the angle-iron had parted along the upper portion of the boiler end.

As to the strain along the bottom of the shell, he had found the addition of T iron strips along the bottom did not prevent this, and he believed it arose entirely from want of circulation in the water. The plan of a centre wall dividing the flue, with the boiler resting upon it, he considered objectionable; for any leakage of water trickled down to that point, and was absorbed by the centre wall like a sponge, acting as a constant source of corrosion to the boiler.

Imperfect circulation of water formed, he believed, the most serious defect in boilers; and in many of the two-flued boilers this was chiefly owing to their not having a sufficient water space between the flues and shell. He had long been convinced of the importance of insuring a much better circulation of water being regularly maintained in boilers; and he contemplated effecting this by direct mechanical means.

Mr. D. Adamson thought it was certainly advisable to have the gusset stays for support to the end plates of a boiler, and he did not see that any thing could be gained by transferring all the action to one joint; but, on the contrary, there was this important disadvantage to be considered—that if a plate were bent backwards and forwards continually, it might fail ultimately, though not subjected at any one time to too severe a strain; if all the buckling action were thrown on the end plate, it would be simply a question of time as to its ultimate failure. On that account, he thought gusset stays should not be abandoned, and they served also as a good support against collapse; he should also recommend longitudinal stays to be retained in addition, for relieving the strain upon the boiler end joints and the circular seams of the boiler shell.

The Chairman said, he had two-flued boilers at his works, that had been in constant use for fifteen years, and no repairs had been wanted to them yet, and he had found them completely satisfactory; but then he never used angle-iron in the construction of such boilers, considering there was not space enough for the plate to spring with the additional thickness of the angle-iron. The plates of the shell, and the flues, were all flanched over at the ends for riveting to the end plates, requiring, of course, best material for the plates; the water spaces he made never less than 6 inches, and preferred 8 inches; this construction gave great flexibility to the ends of the boiler, and there was no danger of failure, he believed, until the boiler was actually worn out with age.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. Faraday, D. C. L., F. R. S.

Lecture V. (Jan. 6, 1860.)—*Magnetism.—Electricity.*

I wonder whether we shall be too deep to-day or not. Remember, that we spoke of the attraction by gravitation of *all* bodies to all bodies by their simple approach. Remember, that we spoke of the attraction of particles of the *same* kind to each other,—that power which keeps them together in masses,—iron attracted to iron, brass to brass, or water to water. Remember, that we found, on looking into water, that there were particles of two different kinds attracted to each other; and this was a great step beyond the first simple attraction of gravitation; because here we deal with attraction between *different* kinds of matter. The hydrogen could attract the oxygen and reduce it to water, but it could not attract any of its own particles, so that there we obtained a first indication of the existence of *two* attractions.

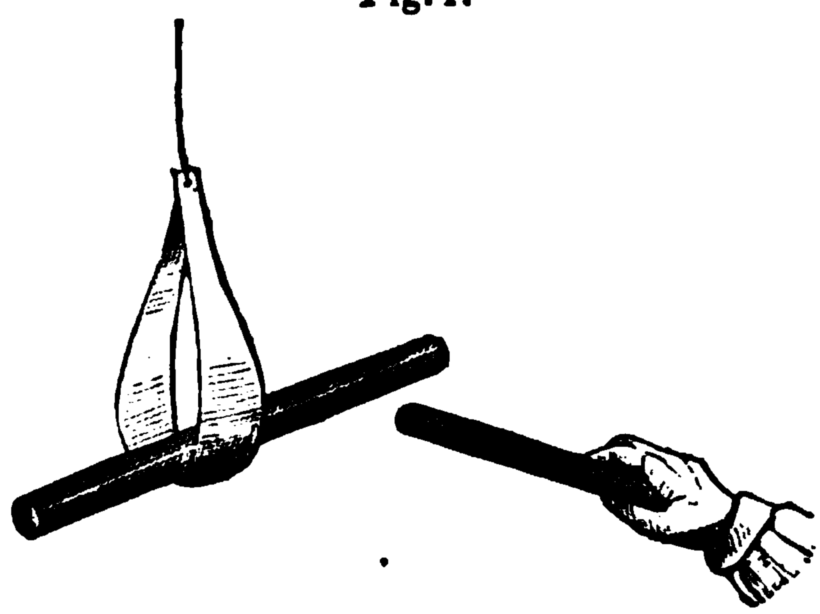
To-day we come to a kind of attraction even more curious than the last, namely, the attraction which we find to be of a double nature—of a curious and dual nature. And I want first of all to make the nature of this doubleness clear to you. Bodies are sometimes endowed with a wonderful attraction, which is not found in them in their ordinary state. For instance, here is a piece of shellac, having the attraction of gravitation, having the attraction of cohesion, and if I set fire to it, it would have the attraction of chemical affinity to the oxygen in the atmosphere. Now all these powers we find *in* it as if they were parts of its substance; but there is another property which I will try and make evident by means of this ball, this bubble of air [a light india-rubber ball, inflated and suspended by a thread]. There is no attraction between this ball and this shellac at present; there may be a little wind in the room slightly moving the ball about, but there is no attraction. But if I rub the shellac with a piece of flannel [rubbing the shellac, and then holding it near the ball], look at the attraction which has arisen out of the shellac, simply by this friction, and which I may take away as easily by drawing it gently through my hand. [The Lecturer repeated the experiment of exciting the shellac, and then removing the attractive power by drawing it through his hand.] Again you will see I can repeat this experiment with another substance; for if I take a glass rod and rub it with a piece of silk covered with what we call amalgam, look at the attraction which it has, how it draws the ball towards it; and then, as before, by quietly rubbing it through the hand, the attraction will be all removed again to come back by friction with this silk.

But now we come to another fact. I will take this piece of shellac, and make it attractive by friction; and remember that whenever we get an attraction of gravity, chemical affinity, adhesion, or electricity (as in this case), the body which attracts is attracted also, and just

* From the Lond. Chemical News, No. 9.

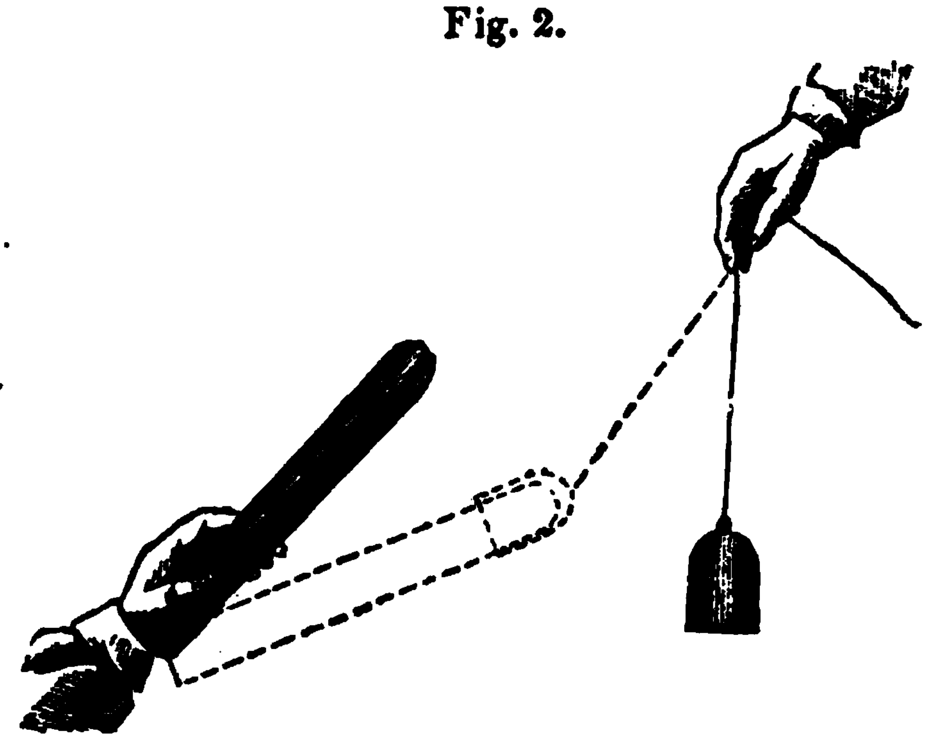
as much as that ball was attracted by the shellac, the shellac was attracted by the ball. Now I will suspend this piece of excited shellac in a little paper stirrup, in this way (Fig. 1), in order to make it move easily, and I will take another piece of shellac, and after rubbing it with flannel, will bring them near together: you will think that they ought to attract each other, but now what happens? It does not attract; on the contrary, it very strongly *repels*, and I can thus drive it round to any extent. These therefore, repel each other, although they are so strongly attractive—repel each other to the extent of driving this heavy piece of shellac round and round in this way. But if I excite this piece of shellac as before, and take this piece of glass and rub it with silk and then bring them near, what think you will happen? [The Lecturer held the excited glass near the excited shellac, when they attracted each other strongly.] You see, therefore, what a difference there is between these two attractions,—they are actually two *kinds* of attraction concerned in this case, quite different to any thing we have met with before; but the *force* is the same. We have here then a double attraction—a dual attraction or force—one attracting and the other repelling.

Fig. 1.



Again, to show you another experiment which will help to make this clear to you. Suppose I set up this rough indicator again [the excited shellac suspended in the stirrup]; it is rough, but delicate enough for my purpose; and suppose I take this other piece of shellac, and take away the power, which I can do by drawing it gently through the hand; and suppose I take a piece of flannel (Fig. 2) which I have

Fig. 2.



shaped into a cap for it, and made dry. I will put this shellac into the flannel, and here comes out a very beautiful result. I will rub this shellac and the flannel together (which I can do by twisting the shellac round), and leave them in contact; and then if, I ask, by bringing them near our indicator, what is the attractive force? it is nothing! But if I

take them apart, and then ask what will they do when they are separated,—why the shellac is strongly repelled, as it was before, but the cap is strongly attractive; and yet if I bring them both together again, there is no attraction—it has all disappeared [the experiment was repeated]. Those two bodies therefore still contain this attractive power —when they were parted it was evident to your senses that they had it, though they do not attract when they are together.

This, then, is sufficient in the outset to give you an idea of the nature of the force which we call ELECTRICITY. There is no end to the things from which you can evolve this power. When you go home take a stick of sealing-wax—I have rather a large stick, but a smaller one will do—and make an indicator of this sort (Fig. 3). Take a watch-glass (or your watch itself will do, you only want something which shall have a round face), and now if you place a piece of flat glass upon that, you have a very easily moved centre; and if I take this lath and put it on the flat glass (you see I am searching for the centre of gravity of this lath, I want to balance it upon the watch-glass), it is very easily moved round, and if I take this piece of sealing-wax and rub it against my coat, and then try whether it is attractive [holding it near the lath], you see how strong the attraction is; I can even draw it about. Here, then, you have a very beautiful indicator, for I have with a small piece of sealing-wax and my coat pulled round a plank of that kind, so you need be in no want of indicators to discover the presence of this attraction. There is scarcely a substance which we may not use. Here are some indicators (Fig. 4). I bend round a strip of paper into a hoop and we have as good an indicator as can be required; see how it rolls along, traveling after the sealing-wax. If I make them smaller, of course we have them running faster, and sometimes they are actually attracted up into the air. Here also is a little collodion balloon. It is so electrical that it will scarcely leave my hand unless to go to the other. See how curiously electrical it is; it is hardly possible for me to touch it without making it electrical; and here is a piece which clings to any thing it is brought near, and which it is not easy to lay down. And here is another substance, gutta-percha, in thin strips; it is astonishing how by rubbing this in your hands you make it electrical; but our time forbids us to go farther into this subject at present; you see clearly there are two kinds of electricities which may be obtained by rubbing shellac with flannel or glass with silk.

Fig. 3.

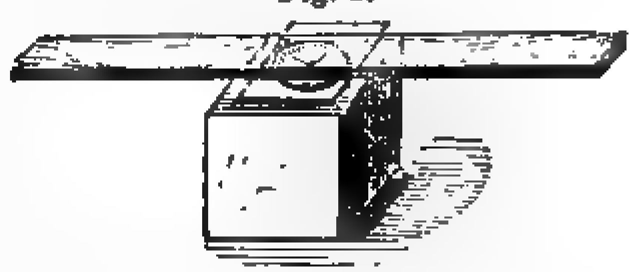


Fig. 4.

Now there are some curious bodies in nature (of which I have two specimens on the table) which are called *magnets* or *loadstones;* ores of iron, of which there is a great deal sent from Sweden. They have the attraction of gravitation, and attraction of cohesion, and certain

chemical attraction; but they also have a great attractive power, for this little key is held up by this stone. Now, that is not chemical attraction, it is not the attraction of chemical affinity, or of aggregation of particles, or of cohesion, or of electricity (for it will not attract this ball if I bring it near it), but it is a separate and dual attraction, and what is more, one which is not readily removed from the substance, for it has existed in it for ages and ages in the bowels of the earth. Now we can make artificial magnets (you will see me to-morrow make artificial magnets of extraordinary power). And let us take one of these artificial magnets, and examine it, and see where the power is in the mass, and whether it is a dual power. You see it attracts these keys, two or three in succession, and it will attract a very large piece of iron. That then is a very different thing indeed to what you saw in the case of the shellac, for *that* only attracted a light ball, but here I have several ounces of iron held up. And if we come to examine this attraction a little more closely, we shall find it presents some other remarkable differences; first of all, one end of this bar (Fig. 5) attracts this key, but the middle does not attract. It is not then the *whole* of the substance which attracts. If I place this little key in the middle it does not adhere; but if I place it *there*, a little nearer the end, it does, though feebly. Is it not then very curious to find that there is an attractive power at the extremities which is not in the middle?—to have thus in one bar two places in which this force of attraction resides. If I take this bar and balance it carefully on a point so that it will be free to move round, I can try what action this piece of iron has on it. Well, it attracts one end, and it also attracts the other end, just as you saw the shellac and the glass did, with the exception of its

Fig. 5.

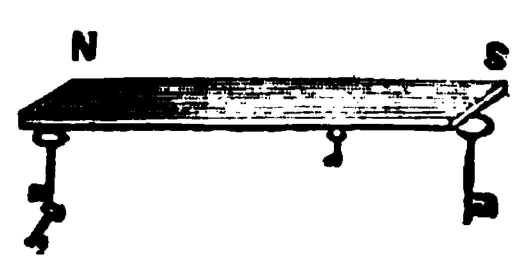
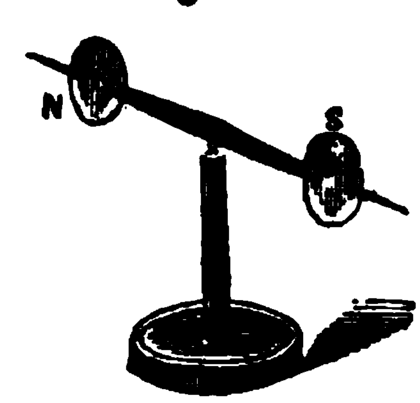


Fig. 6.



not attracting in the middle. But if now, instead of a piece of iron, I take a *magnet*, and examine it in a similar way, you see that one of its ends *repels* the suspended magnet; the force then is no longer attraction but repulsion; but, if I take the other end of the magnet and bring it near, it shows attraction again.

You will see this better, perhaps, by another kind of experiment. Here (Fig. 6) is a little magnet, and I have colored the ends differently so that you may distinguish one from the other. Now this end (. . . .) of the magnet (Fig. 5) attracts the *uncolored* of the little magnet. You see it pulls it towards it with great power. And as I carry it round, the uncolored end still follows. But now if I gradually bring the middle of the bar magnet opposite the uncolored end of the needle, it has no effect upon it, either of attraction or repulsion, until,

as I come to the opposite extremity (. . . .) you see that it is the *colored* end of the needle which is pulled towards it. We are now therefore dealing with two kinds of power, attracting different ends of the magnet—a double power, already existing in these bodies, which takes up the form of attraction and repulsion. And now when I put up this label with the word MAGNETISM, you will understand that it is to express this double power.

Now with this loadstone you may make magnets artificially. Here is an artificial magnet (Fig. 7) in which both ends have been brought together in order to increase the attraction. This mass will lift that lump of iron, and what is more, by placing this *keeper*, as it is called, on the top of the magnet, and taking hold of the handle, it will adhere sufficiently strongly to allow itself to be lifted up, so wonderful is its power of attraction. If you take a needle, and just draw one of its ends along one extremity of the magnet, and then draw the other end along the other extremity, and then gently place it on the surface of some water (the needle will generally float on the surface, owing to the slight greasiness communicated to it by the fingers), you will be able to get all the phenomena of attraction and repulsion, by bringing another magnetized needle near to it.

Fig. 7.

I want you now to observe that although I have shown you in these magnets that this double power becomes evident principally at the extremities, yet the *whole* of the magnet is concerned in giving the power.

That will at first seem rather strange, and I must therefore show you an experiment to prove that this is not an accidental matter, but that the whole of the mass is really concerned in this force, just as in falling the whole of the mass is acted upon by the force of gravitation. I have here (Fig. 8) a steel bar, and I am going to make it a magnet by rubbing it on the large magnet (Fig. 7). I have now made the two ends magnetic in opposite ways. I do not at present know one from the other, but we can soon find out. You see when I bring it near our magnetic needle (Fig. 6) one end repels and the other attracts; and the middle will neither attract nor repel—it *cannot*, because it is *half-way between the two ends.* But now, if I break out that piece (*n. s.*) and then examine it—see how strongly one end (*n*) pulls at this end (S, Fig. 6) and how it repels the other end (N). And so it can be shown that every part of the magnet contains this power of attraction and repulsion, but that the power is only rendered evident at the end of the mass. You will understand all this in a little while, but what you have now to consider is that every part of this steel is in itself a magnet. Here is a little fragment which I have broken out of the very centre of the bar, and you will still see that one end is attractive and the other is repulsive. Now, is not this power a most wonderful thing? And very strange, the means of taking it from one substance and bringing it to other matters. I cannot make a piece of iron or any thing else heavier or lighter than it is; its cohesive power

Fig. 8.

it must and does have; but as you have seen by these experiments, we can add or subtract this power of magnetism, and almost do as we like with it.

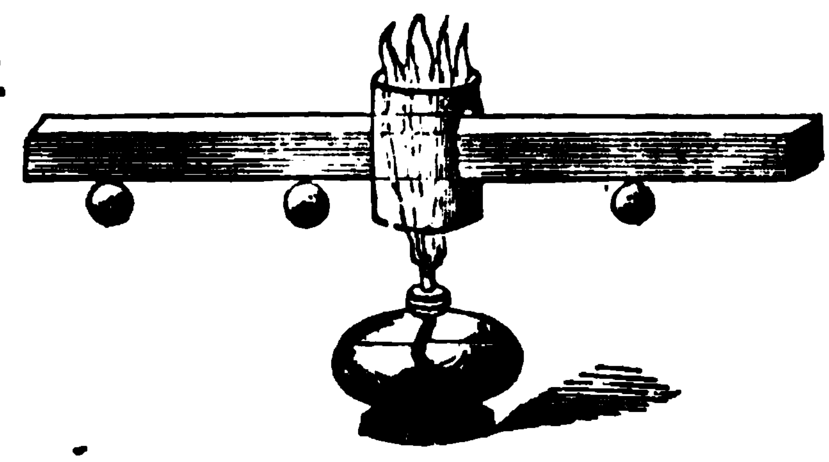
And now we will return for a short time to the subject treated of at the commencement of this lecture. You see here (Fig. 9) a large machine got up for the purpose of rubbing glass with silk and for obtaining the power called *electricity;* and the moment the handle of the machine is turned a certain amount of electricity is evolved, as you will see by the rise of the little straw indicator (. . . .). Now I know from the appearance of repulsion of the pith ball at the end of the straw that the electricity is present in those brass conductors (. . . .), and I want you to see the manner in which that electricity can pass away [touching the conductor (. . .) with his finger, the Lecturer drew a spark from it, and the straw electrometer immediately fell]. There, it has all gone; and that I have really taken it away you shall see by an experiment of this sort. If I hold this cylinder of brass by the glass handle and touch the conductor with it I take away a little of the electricity. You see the spark in which it passes, and observe that the pith ball indicator has fallen a little, which seems to imply that so much electricity is lost; but it is not lost, it is here in this brass, and I can take it away and carry it about, not because it has any substance of its own, but by some strange property which we have not before met with as belonging to any other force. Let us see whether we have it here or not. [The Lecturer brought the charged cylinder to a jet from which gas was issuing; the spark was seen to pass from the cylinder to the jet, but the gas did not light.] Ah! the gas did not light, but you saw the spark; there is perhaps some draft in the room which blew the gas on one side, or else it would light; we will try this experiment afterwards. You see from the spark that I can transfer the power from the machine to this cylinder, and then carry it away and give it to some other body. You know very well as a matter of experiment that we can transfer the power of heat from one thing to another; for if I put my hand near the fire it gets hot. I can show you this by placing before us this ball which has just been brought red-hot from the fire. If I press this wire to it some of the heat will be transferred from the ball, and I have only now to touch this piece of gun-cotton with the hot wire and you see how I can transfer the heat from the ball to the wire and from the wire to the cotton. So you see that some powers are transferable and others are not. Observe how long the heat stops in this ball. I might touch it with the wire, or with my finger, and if I did so quickly, I should merely burn the surface of the

Fig. 9.

skin; whereas if I touch that cylinder however rapidly with my finger the electricity is gone at once—dispersed on the instant, in a manner wonderful to think of.

I must now take up a little of your time in showing you the manner in which these powers are transferred from one thing to another; for the manner in which *force* may be conducted or transmitted is extraordinary, and most essential for us to understand. Let us see in what manner these powers travel from place to place. Both heat and electricity can be conducted; and here is an arrangement I have made to show how the former can travel. It consists of a bar of copper (Fig. 10), and if I take a spirit-lamp (this is one way of obtaining the power of heat) and place it under that little chimney, the flame will strike against the bar of copper and keep it hot. Now you are aware that power is being transferred from the flame of that lamp to the copper, and you will see by-and-by that it is being conducted along the copper from particle to particle; for, inasmuch as I have fastened these wooden balls by a little wax at particular distances from the point where the copper is first heated, first one ball will fall and then the more distant ones, as the heat travels along, and thus you will learn that the heat travels gradually through the copper. You will see that this is a very slow conduction of power as compared with electricity. If I take cylinders of wood and metal joined together at the ends and wrap a piece of paper round and then apply the heat of this lamp to the place where the metal and wood join, you will see how the heat will accumulate where the wood is, and burn the paper with which I have covered it; but where the metal is beneath the heat is conducted away too fast for the paper to be burned. And so if I take a piece of wood and a piece of metal joined together, and put it so that the flame shall play equally both upon one and the other, we shall soon find that the metal will become hot before the wood; for if I put a piece of phosphorus on the wood, and another piece on the copper, you will find that the phosphorus on the copper will take fire before that on the wood is melted; and this shows you how badly the wood conducts heat. But with regard to the traveling of electricity from place to place its rapidity is astonishing. I will, first of all, take these pieces of glass and metal, and you will soon understand how it is that the glass does not lose the power which it acquired when it is rubbed by the silk; by one or two experiments I will show you. If I take this piece of brass and bring it near the machine, you see how the electricity leaves the latter and passes to the brass cylinder. And again, if I take a rod of metal and touch the machine with it I lower the indicator, but when I touch it with a rod of glass no power is drawn away, showing you that the electricity is conducted by the glass and the metal in a manner entirely different; and to make you see that

Fig. 10.



more clearly we will take one of our Leyden jars. Now, I must not embarrass your minds with this subject too much, but if I take a piece of metal and bring it against the knob at the top and the metallic coating at the bottom you will see the electricity passing through the air as a brilliant spark. It takes no sensible time to pass through this, and if I were to take a long metallic wire, no matter what the length, at least as far as we are concerned; and if I make one end of it touch the outside and the other touch the knob at the top—see how the electricity passes!—it has flashed instantaneously through the whole length of this wire. Is not this different from the transmission of heat through this copper bar (Fig. 10), which has taken a quarter of an hour or more to reach the first ball?

Here is another experiment, for the purpose of showing the conductibility of this power through some bodies and not through others. Why do I have this arrangement made of brass? [pointing to the brass work of the electrical machine, Fig. 9.] Because it conducts electricity.

Fig. 11.

And why do I have these columns made of glass? Because they obstruct the passage of electricity. And why do I put that paper tassel (Fig. 11) at the top of the pole, upon a glass rod, and connect it with this machine by means of a wire? You see at once that as soon as the handle of the machine is turned the electricity which is evolved travels along this wire and up the wooden rod, and goes to the tassel at the top, and you see the power of repulsion with which it has endowed these strips of paper, each spreading outwards to the ceiling and sides of the room. The outside of that wire is covered with gutta percha; it would not serve to keep the force from you if you touched it with your hands, because it would burst through, but it answers our purpose for the present. And so you see how easily I can manage so as to send this power of electricity from place to place by choosing the materials which can conduct the power. Suppose I want to fire a portion of gunpowder, I can readily do it by this transferable power of electricity. I will take a Leyden jar, or any other arrangement which gives us this power, and arrange wires so that they may carry the power to the place I wish; and then placing a little gunpowder on the extremities of the wires, the moment I make the connexion by this discharging rod, I shall fire the gunpowder [the connexion was made and the gunpowder ignited]. And if I were to show you a stool like this, and were to explain to you its construction, you could easily understand that we use glass legs because these are capable of preventing the electricity from going away

to the earth. If, therefore, I were to stand on this stool and receive the electricity through this conductor I could give it to any thing that I touched. [The Lecturer stood upon the insulating-stool and placed himself in connexion with the conductor of the machine.] Now I am electrified, I can feel my hair rising up as the paper tassel did just now. Let us see whether I can succeed in lighting gas by touching the jet with my finger. [The Lecturer brought his finger near a jet from which gas was issuing, when after one or two attempts the spark which came from his finger to the jet, set fire to the gas.] You now see how it is that this power of electricity can be transferred from the matter in which it is generated, and conducted along wires and other bodies, and thus be made to serve new purposes utterly unattainable by the powers we have spoken of on previous days; and you will not now be at a loss to bring this power of electricity into comparison with those which we have previously examined, and to-morrow we shall be able to go farther into the consideration of these transferable powers.

(To be Continued.)

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*Steam Boiler Explosions.** By J. W. Clare, C. E.

I have devoted considerable attention for many years to the causes of steam boilers exploding, and in collecting data to form more definite rules to judge of their strength and capabilities. It is a fact not generally known, that boiler breakers are much better acquainted with the causes of steam boiler explosions than boiler makers, and it should be more generally known by the public that there is no mystery whatever in the case, but that they arise simply from causes that may easily be avoided or prevented. Some eighteen years since, I came to the conclusion that, as medical men obtained an insight as to the causes of diseases in the human system during life, by dissecting and examining the body after death, I would adopt the same plan with old steam boilers of all classes, and especially those which had exploded, to arrive at better remedies for their general defects and weakness. With this view, I have repeatedly scraped off the rust from several places on the outside, and the scale also from the inside, of all descriptions of old steam boilers, and then watched their being broken up, and examined the plates afterwards; and from this experience, combined with general observation at various boiler makers, and of a large number in use, I have formed the following conclusions:—

First, from the competition among boiler makers to undersell each other a great deal of plate and angle-iron has been used in the construction of boilers that is quite unfit for the purpose; for all boiler iron should be effectually piled different ways before being placed in the furnace, to ensure the fibre or grain of the iron extending in all directions in the plane of the surface.

Secondly, that punching out one-third of the iron down the sides of the plates, with the grain of the metal, driving into these holes a

* From the London Engineer, No. 235.

steel drift, to force them opposite to each other, and then driving the inner edge of the plate under with steel caulking irons, all tends to granulate and strain the metal left between the rivets. Whereas, if the holes were all drilled through both the plates at once, and arranged to form a double zigzag line, and a slip of spun yarn and white lead, or other suitable packing, laid in between the two lines of rivets, much less caulking would be sufficient, and these joints, and consequently the whole boiler, could be more securely depended upon. And as by inspecting the plates we could form more correct opinions as to the strength of boilers than we can by the present plan of putting them together, I have continually found the metal between the holes so much deteriorated, that sharp blows with a sledge-hammer would split several of them into each other; and I have carefully sawn out thin strips of the metal from between the holes and compared them with similar pieces from other parts of the same plate, and invariably found the metal from between the holes was more brittle than any other. And I have always found that where plates had been drilled and bolted on with bolts and nuts for patches on old boilers, the metal between the holes was not injured. I have also found, that where patches were riveted on and caulked, the metal between the holes in the boiler was much more deteriorated than that between the holes of the patch; and from this I have inferred, that after boiler-paltes have been acted upon by heat and oxidation they will not bear being hammered without greatly reducing their power of adhesion along the line over which the hammer has been used.

Thirdly, many large boilers are worked up to a higher pressure than formerly, in proportion to their weight and strength, being hard fired to a power beyond their capabilities. When do we hear of a steam boiler exploding among the hundreds of small boilers used by shopkeepers and others in a small way of business, who have not sufficient work to strain them?

Fourthly, many manufacturers use their boilers too long a time for safety; I have frequently seen different parts of plates in old boilers, less than one-eighth of an inch thick, and in other cases the metal of the plates so perished, as not to bear being bent to a greater angle than 30 deg. without fracture. From this I argue that while the strain upon a boiler-plate continues in one direction, it may be worked until worn to within one-half its original thickness without risk of explosion at the usual working pressure; but that if any thing occurs to bend or twist the grain of the metal, either by hammering, unequal expansion or contraction, or any other cause, the limit of elasticity is so greatly reduced as to render it incapable to withstand the usual direct strain. And lastly, boilers frequently leak unperceived into one of the flues, and oxidation goes on more rapidly than usual. I will pass over such causes as malconstruction, negligence, wilfulness, &c., and merely observe, in conclusion, that if all persons were compelled to inform a competent surveyor when they fixed a new boiler, and it was his duty to go and examine it, keep an account of the date, and have the power of condemning it if unsafely constructed, as also the

power to go and examine it whenever he thought proper, and of condemning it when it was worn or had become dangerous to public safety: the users of steam boilers might in time be taught that it was entirely to their own interest to have a boiler of the best material and the best construction, such boilers being ultimately, when all expenses are considered, invariably the least expensive.

3, Surrey-square, S. E., June 26, 1860.

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*Fastening Railway Wheel Tires.** By J. C. Pearce.

The consequences resulting from the ordinary defective method of fastening the tires of railway wheels having again recently drawn some attention to the subject, induces me to offer to your notice a new plan, patented some two years ago by Mr. E. Turner, of the Bowling Iron Company, in conjunction with myself, which, though but comparatively little known, is unquestionably the most perfect fastener in use. It presents no difficulties to be overcome in the formation of the tire and wheel-rim, neither is its application confined to any particular section of tire, &c.; but, on the contrary, its simplicity renders it easily applied to all.

A dovetailed groove is formed around the inner surface of the tire, corresponding with a similar groove formed around the wheel-rim, as shown in the accompanying illustrations. The tire, after being shrunk on the wheel in the usual way, is turned and finished so as to allow ample opportunity for the detection of bad welding or other imperfection. The wheel is then placed in an horizontal position, and the double dovetailed ring is cast into the grooves through holes, similar to rivet holes, in the wheel-rim. The ring thus formed constitutes a continuous rivet all round the wheel, holding both rim and tire firmly together, and rendering it impossible for the latter to get out of position in the event of fracture.

The plan here described is applied to engine and carriage wheels, and has been in successful operation more than two years. Various interests and prejudices will doubtless delay its general adoption, but it is gradually working its way into favor.

There should be no excuse to shield railway companies from the responsibility of accidents arising from the fracture of wheel tires while they possess the means of rendering such accidents perfectly harmless, if not impossible.

July 16, 1860.

* From the Lond. Mechanics' Mag., July, 1860.

Determination of Organic Matter in Water.

M. Emile Monnier presented to the Academy of Sciences of Paris, an interesting note on the determination of the organic matters in the waters of the Seine. The re-agent which he employs is the per-manganate of potassa. The weight of this salt decomposed being sensibly proportional to that of the organic matter, the problem is reduced to the determination of the weight of per-manganate decolored by a given quantity of the water.

The test-liquor which he employs is prepared by dissolving one gramme of pure per-manganate in one litre of distilled water; each cubic centimetre of this liquid contains one milligramme of the salt. To perform an analysis proceed as follows:

Pour into a matrass a half-litre (about a pint) of the water and bring it to the temperature of 158° F.; add through a pipette 1 cubic centimetre of pure sulphuric acid; then add the test-liquor until a permanent coloration is produced; the number of cubic centimetres of this liquor added, gives at once in milligrammes the weight of the re-agent decomposed by one litre of water. At about 158° F. the decomposition of the organic matters is rapid; at common temperatures it would require more than 24 hours to be complete.

The sensibility of the per-manganate is very great; one gramme of tannin in 2 cubic metres (or one part of tannin to two million parts of water) and even one part by weight of sulphuretted hydrogen in eleven million parts of water will discolor it.—*Cosmos.*

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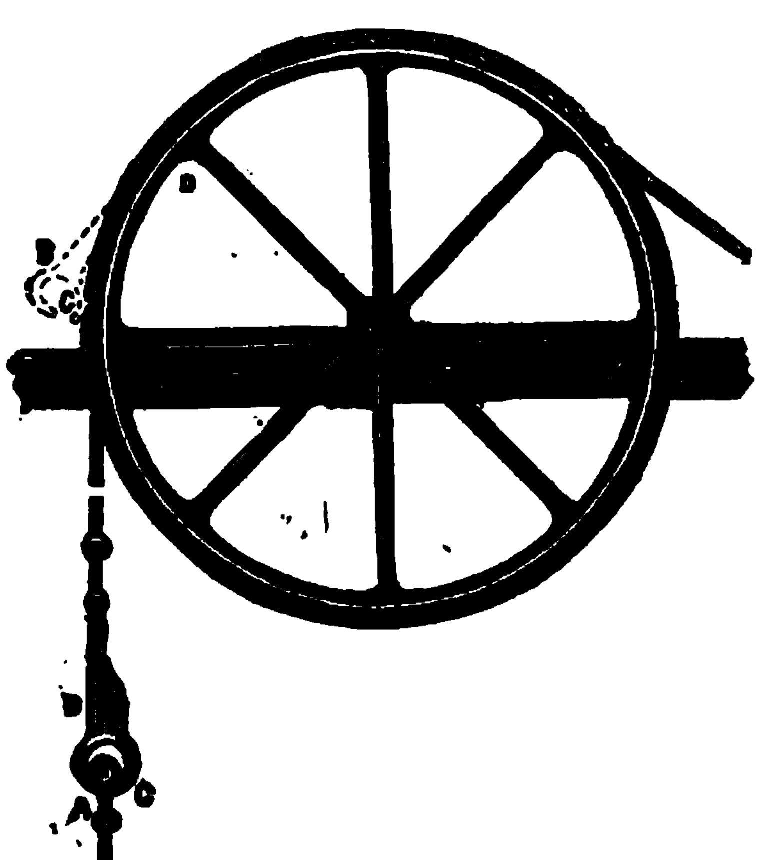
*On a Self-acting Disengaging Hook.**

The frequency and fatal consequences of accidents arising from over winding or drawing the cage over the head gear pulley, have called the attention of colliery owners and inspectors to the means whereby such accidents may be avoided in future. The annexed engraving represents a self-acting spring hook, the invention of Mr. Robert Walker, of Eccleston, near Prescot, colliery viewer. This hook possesses all the qualities requisite to insure its general application in coal and other mines. When this hook is employed, it is impossible to wind the cage up sufficiently high to cause an accident. The mode of action is as follows:—When the cage is rising, the bridle, A, hangs in the hook, B, which is made with a spring catch, C. This catch closes the hook entirely, so that there is no possibility of the cage becoming disengaged in winding; but if, owing to the neglect of



* From the Lond. Practical Mechanic's Journal, August, 1860.

the engine driver, or from any other cause, the cage should be raised until the hook comes against the head gear pulley, D, as shown by the dotted lines, then the hook assumes a diagonal position, and the bridle, A, bearing upon the spring catch, C, causes it to open and to disengage the cage from the hook. When the cage is disengaged it is caught by retaining pawls or other apparatus, to prevent it descending the pit.

For the Journal of the Franklin Institute.

Binocular Vision, Theory of Images on Transparent Media, and the Stereomonoscope. By C. J. W., Jr.

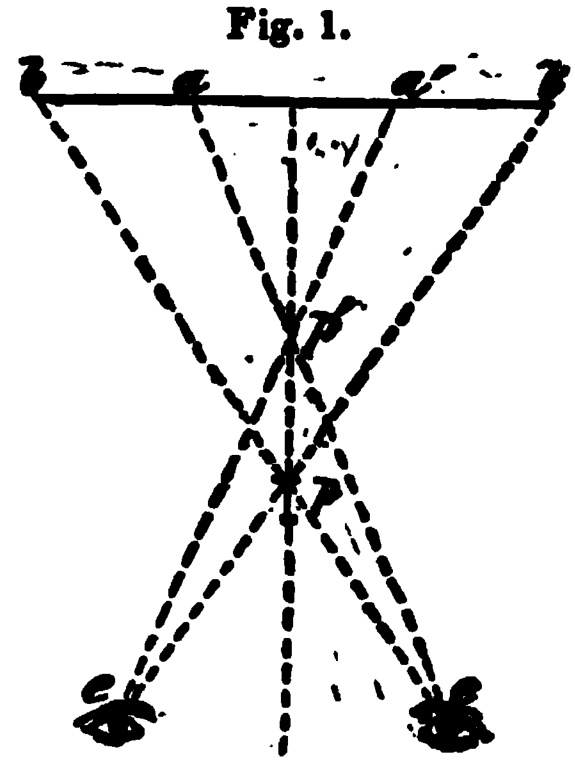
The laws of optics and of binocular vision are so well understood and have been so thoroughly investigated that any detailed recapitulation of them in this place would be supererogatóry. It will, therefore, be necessary merely to allude to such as may have a direct bearing upon the subjects treated of in this article.

In viewing a landscape which possesses the advantage of a variety of planes of distance, first with both eyes simultaneously, and then with the right and left eye alternately, we shall perceive that in all these three instances, near and distant objects occupy different relative positions with regard to each other.

In the latter case, where the view is with either eye alternately, near objects will appear to have moved with regard to more distant ones, to the right when the right eye is closed and to the left when the left eye is closed.

Of course the reverse is the case when distant objects are viewed with regard to near ones. The amount of apparent motion will be in proportion to the relative direct distances of the observer from the objects viewed and of the objects from each other. In case, however, of vision with the eyes simultaneously, when the optic axes are directed to any point it will not appear in either of the positions to which it has been referred by the eyes separately, but will assume an intermediate one.

Fig. 1.



If *ee* (Fig. 1) represent the eyes, it will be seen that by closing them alternately, the near point *p* will have an apparent motion *bb'* when referred to that line; while the more distant point *p'* will only have an apparent motion *aa'* when referred to the same line; whereas if both eyes be turned to the points *p*, *p'* respectively, they will occupy an intermediate position between these two extremes.

When the optic axes are converged upon distant points, indistinct duplicate images of nearer points will be visible, separated in proportion to their proximity to the observer, and occupying the positions to the right and to the left respectively which they occupied when viewed

with either eye alternately, and *vice versa*, when the optic axes are directed to near points, distant ones are then duplicated and occupy the positions in which they were seen when viewed with the eyes successively. If the head is held out of the perpendicular so that a line joining the eyes shall not be a horizontal line, and the eyes fixed upon a distant point, the two images of a near point received by them will likewise be unequally elevated; that image being most depressed which is seen by the eye that is most elevated, and *vice versa*, that image most elevated which is seen by the eye that is most depressed.

All these phenomena are in perfect harmony with the law of visible direction, the integrity of which is preserved throughout. In the cases last alluded to, the elevated eye receiving the image by virtue of an ascending ray, and in obedience to this law, seeing it in a direction perpendicular to a plane tangent to the retina at the point of contact of this incident ray, receives the impression of a less elevated object. The other eye, however, perceiving the image by a ray less inclined, receives the impression of a more elevated object. The rays in both instances issuing from the same object, though entering the eyes with different degrees of inclination.

If we now, with a binocular camera properly constructed, having its lenses equally separated with the eyes of the observer, take photographic pictures of the objects before us and look at them with the assistance of the stereoscope, we shall be able to repeat all the experiments above suggested with the same results as when we were viewing the natural objects whose fac similes we are now in possession of.

These two dissimilar perspectives, taken at points two and a half inches distant, faithfully represent the right and left hand monocular views, and by alternately closing the right and left eye, near and distant objects will undergo changes in their relative position, precisely as they were seen to do in our natural vision of the landscape.

It is to the coincidence of these two dissimilar perspectives, effected by different degrees of convergency of the optic axes, that the stereoscopic illusion of solidity and relief is to be ascribed.

Allied to this in result, though effected through various ocular processes, are many other phenomena of vision, classified under the general title of optical illusions. Among the most noticeable of these is the relief produced by the copying of medals and other raised surfaces by the ruling machine.

This, like the one under discussion, is but another form of the projection of solids upon flat surfaces, the elevations and depressions of the medal corresponding with the different planes of distance of the stereoscopic object; and the effect of the deviation of parallel lines from their original parallelism in coming in contact with planes placed at all varieties of angles and of unequal elevations, in the one case, corresponding with the effect of the combination of dissimilar perspectives in the other.

This illusion of relief might also be in a measure produced, or at least enhanced, by calling into requisition the power of focal adjustment of the eye in connexion with the different degrees of refrangi-

bility of the prismatic colors. By giving objects intended to appear in relief that color whose ray is least refrangible, and those intended to recede from the eye, that color whose ray is most refrangible, we should invest them with at least one attribute of proximity and distance. In the former case the less refrangible ray would correspond in focal adjustment with the diverging rays of near objects, while in the latter case the more refrangible rays would correspond in focus with parallel rays of distant objects.

To this different degree of refrangibility of the prismatic rays may be ascribed the peculiarly unpleasant dazzling effect experienced in passing the eyes rapidly over certain combinations of colors. If the extremes of the solar spectrum representing the maximum and minimum of refrangibility be rapidly and consecutively presented to the eyes, each requiring a different focal adjustment to produce distinct vision, it can easily be conceived that the effect would be dazzling and confused.

In these latter instances the illusion would evidently be much more perfect if one eye alone were used ;. convergency now coming to our aid as a most powerful adjunct in dispelling an illusion, which, in the first case cited,—that of the stereoscope—it was exclusively instrumental in producing.

All these cases afford striking instances of the liability to error incurred by implicit reliance upon the evidence of any one witness, however perfect in itself; truth is only to be established by the concurrent testimony of all those with which nature has provided us for protection from deception and imposture, and for our better acquaintance with the works with which she has surrounded us.

We will now lay aside the photographic representations of the landscape, and with the aid of the stereoscope examine the images themselves as they appear depicted upon the ground glass of our binocular camera. In so doing a most unexpected and illusive effect will be produced.

All our previous knowledge of the distances of the various objects in view, is now completely at variance with the confused and illusive evidence of our senses.

We know, for example, that the sky is far more distant than the trees, and yet are small blue patches of it boldly protruding through apertures of the foliage and advancing into the foreground, while trees and their branches, known to be almost within our grasp, are modestly retiring and hiding themselves behind the distant skies. In fact, some potent spell appears suddenly to have inverted the entire order of things. Trunks of prominent trees seem to be sinking into, and almost enveloped by foliage that is behind them. Shadowy visions of leaves yielding to the breeze appear to pass behind the branches which they are actually placed in advance of, and which appear to have become magically endowed with transparency for the accommodation of the observer. In a word, the illusion is complete. All distant objects appear at hand, and all near objects far, in proportion to their proximity.

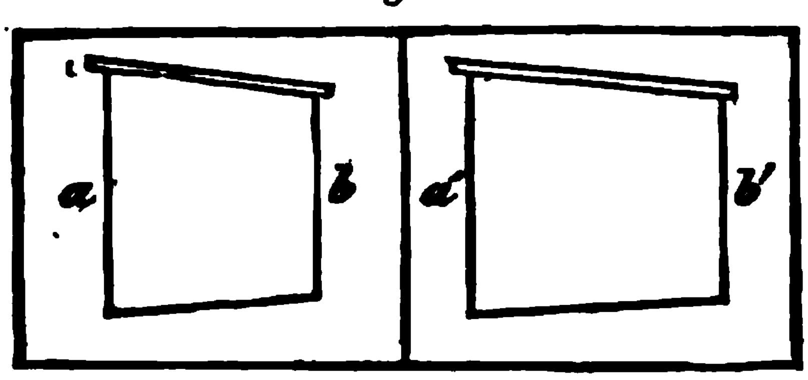
If Sir David Brewster's theory of the stereoscope required another

proof of its correctness, it would be found in this simple and interesting experiment; and it is a little singular that he makes no allusion to it in his work on that subject. In the case before us we find nearly all the elements essential to the formation of correct estimates of distance, such as magnitude, definition, perspective, &c., arrayed in direct antagonism to one solitary test, which is left to rebut their testimony single-handed and alone. It is that most essential element of vision, convergency, and although but one against many, it proves too strong for them all. For it is only by previous knowledge of the position of the objects of the landscape, or through some other means of information than the present modified form of vision affords, that we are enabled to dispel the illusion under which we labor, and be reassured of the actual order of nature.

A key to the mystery, however, is at hand. It will be found by analyzing the dissimilar perspectives projected upon the ground glass, that our lenses in inverting each picture separately have also inverted or rather reversed the relative horizontal separation of similar points of the various planes of distance upon which the stereoscopic effect depends.

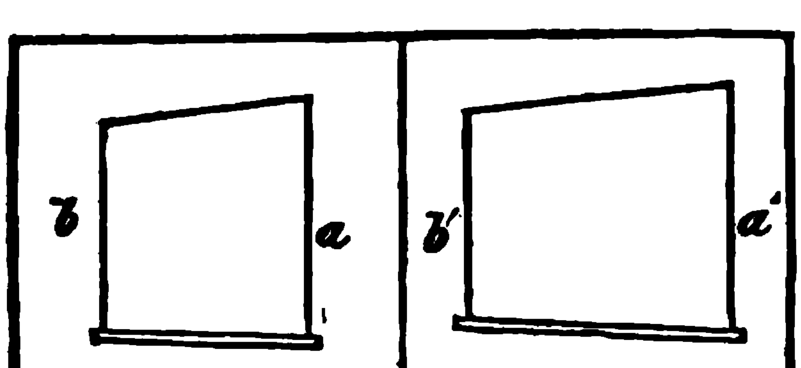
Similar points of near planes will now be found to be more distantly separated than similar points of distant planes. Whereas, in the erect pictures drawn from nature the reverse is the case, similar points of near planes being nearer than those of distant planes.

Fig. 2.



Suppose *a b* and *a′ b′* (Fig. 2) to represent dissimilar perspectives of an object as seen by ordinary vision with the right and left eye alternately—*a a′* represent similar points of near planes, while *b b′* represent similar points of distant planes; *b b′* being more distant from each other than *a a′*. Now suppose these two perspectives to be separately inverted as they are by the lenses of a binocular camera; their position will then be as in Fig. 3.

Fig. 3.



It will there be seen that the lines *b*, *b′*, which were in the first case more distant than *a*, *a′*, now more nearly approach each other. Consequently upon application of the stereoscope to the first pair of dissimilar perspectives, points of near planes will be converged near to the eyes, and points of distant planes more distantly, following the course of natural vision, in which near points require a greater degree of convergency than distant ones.

With the latter pictures, however, the reverse is the case. For similar points of near planes being more separated will be converged at a greater distance than similar points of distant planes. Thus reversing the order of nature and producing that confusion and inversion of distances already described.

These perspectives reversed as they now appear on the ground glass of the camera, are in a proper position to produce a correct impression combined ocularly without the intervention of the stereoscope, provided the image is formed before and not beyond the ground glass; for in that case the greater the separation of corresponding points of perspective, the more nearly to the observer will the points of their coincidence be approached. The image that results from this combination will be diminished in size in proportion as it approaches the eye. Our estimate of its dimensions being formed by the conviction that convergency affords of its increased proximity, together with the impression on the retina, which shows that it subtends the same visual angle, the deduction is, that what is nearer, and yet subtends no greater angle, must be smaller. In viewing these pictures with the stereoscope the effect is quite different, for then convergency is effected at almost the same distance from the eye of the observer as the pictures themselves are placed; there is nothing, therefore, to indicate diminished distance, and consequently no impression of decreased dimensions in the resultant image.

It is owing to this inversion of perspectives that we are obliged to divide the stereoscopic photographs taken by a binocular camera, and reverse their position, in order to produce a proper effect when placed in the stereoscope, and not as has been stated, because we have reversed the pictures in placing the undivided images erect. This certainly puts the right hand picture on the left hand side, but in no degree disturbs the relative distances of similar points, upon which the result wholly depends.

It is an easy problem to place the images in an erect position in the camera, by first receiving them upon a mirror and reflecting them thence upon the ground glass. But this process, although it places the images erect, or rather enables us to view them ourselves in an inverted position, effects no change in the perspectives, and consequently upon application of the stereoscope the illusion of distances remains unchanged.

If, however, we wish to witness the effect of reversing the perspectives in reality at the same time that we place the images in their natural erect position, we have only to place behind each of the object glasses of our camera another lens at a distance greater than the sum of the principal foci of both, (*i.e.* the object and the auxiliary lens,) and permit the landscape to be refracted by both of these lenses upon the ground glass. This arrangement will, of course, have the effect of separately reinverting the images, and will place them in their natural position upon the ground glass, their perspectives perfect, and upon application of the stereoscope we shall perceive a living picture of the landscape before us.

We now come to the beautiful and ingenious discovery of Mr. Claudet.

The writer in adjusting the focus of objects on the ground glass of the camera obscura, had often been struck with the impossibility of obtaining a satisfactory view of the image except from certain angles of observation, and was, therefore, particularly pleased with Mr. Claudet's investigations in elucidation of the mystery.

Mr. Claudet's discovery was announced to the Royal Society in June, 1857, and a notice of it subsequently, July, 1858, copied into this Journal. The author says, "that having observed that the image on the ground glass of the camera obscura appeared as much in relief as the natural objects themselves when seen with two eyes; that his experiments and researches as to the cause, have disclosed the singular fact that though only one image seems depicted thereon, two really exist, one visible only to the right eye and the other only to the left. That the image seen by the former is refracted by the left side of the lens, and that seen by the latter by the right side of the lens. Consequently that these two images presenting two different perspectives, the result is the same as when two different perspectives are viewed with the stereoscope. That all the different images refracted by every part of the lens are each only visible on the line of their refraction when it corresponds with the optic axes."

Mr. Claudet further remarks that if the image be received upon transparent paper instead of ground glass, the illusion of relief is not in the least presented, that all the images refracted from all parts of the lens coincide upon the paper and are visible at whatever angle they are examined. The reason of this difference being that the rays refracted by the lens continue their course in straight lines through the transparent molecules of the ground glass, and are seen only when they coincide with the optic axes; while the paper being perfectly opaque stops all the rays, and becoming itself luminous sends new rays in all directions.

In elucidation of this new principle of ground glass images, Mr. Claudet proposes a number of experiments made with different colored glasses placed before marginal openings of the lens, &c.; and having convinced himself of its correctness, suggests the possibility of a stereoscope being constructed upon this new principle, in which the eyes looking upon a single image could see it in perfect relief. This single image being composed of two images superposed, one visible only to the right eye and the other only to the left.

In a subsequent paper read before the Royal Society in April, 1858, Mr. Claudet states, "that he had succeeded in constructing a stereoscope upon this new principle, to which he had given the name of stereomonoscope, in allusion to its power of producing the stereoscopic effect with apparently but one image."

In pursuance of this interesting subject, the writer has repeated the experiments suggested by Mr. Claudet, some with perfect, all with partial success.

It is not strictly true that, "when looking at the image on the ground glass of a camera obscura, the right eye sees only that refracted by the left side of the lens, and the left eye only that refracted by the right side;" for when the entire lens is exposed, the rays passing through its centre are so slightly converged that each eye receives a portion from both sides of it. The perspectives are thus mingled and the stereoscopic effect greatly impaired.

This is particularly observable when the rays entering the right and

left sides of the lens are passed through different colored glasses. A mingling of colors in the centre will be perceptible to either eye to nearly the same extent as when both are used simultaneously.

In conducting these experiments, therefore, it is desirable to exclude the central rays. This is most effectually accomplished by covering the entire face of the lens, and then making marginal apertures at the extremities of its transverse axis. If the lens used has a diameter of four or five inches with marginal apertures of not more than one or one and a half inches, into which are introduced tubes about six inches long, so as to exclude all rays which will not reach the ground glass but may fall upon other parts of the camera—it will then be in a condition to produce the most striking effect.

The contraction of the marginal apertures not only enhances the effect by the exclusion of unnecessary light, but likewise diminishes spherical aberration by reducing the surface of the lens exposed, and proportionally improves the definition of the image; while the inequality of focal distance of differently distant objects and consequent varying convergency of the refracted rays remains unimpaired. The divergency of rays incident upon the lens being by this arrangement at a maximum.

The result is quite different when rays are admitted through an equal aperture in the centre of the lens; for then all rays from near as well as distant points enter it with nearly the same degree of parallelism, and are consequently refracted to points at nearly the same distance behind the lens, and with nearly the same degree of convergency.

If, with the camera arranged as above described, a piece of blue glass be placed before the right hand aperture of the lens, and a piece of yellow glass before the left, the eyes placed equally distant from the centre of the ground glass, will perceive thereon a union or mingling of both these colors. When viewed, however, with the right and left eye alternately within a certain radius, the yellow ray will alone be perceptible to the right eye and the blue ray only to the left.

If the colored glasses be now removed and the camera turned to the landscape, an effect of relief almost magical will be presented. Supposing the camera to be adjusted to the focus of the nearest visible objects; then, by fixing the eyes steadily upon their images and gradually moving the ground glass in towards the lens until middle and greater distances become distinctly delineated, these images of near objects upon which the eyes are fixed, instead of receding with the ground glass, will remain in their original places, *i.e.* at their respective points of convergency, until they appear to stand out several inches in advance of the rest of the picture; while images of more distant objects not perfectly in focus on the ground glass will appear to be placed equally distant behind it. Upon observing one of these boldly advanced images with both eyes placed directly opposite to it, and then by alternately closing them, it will be seen that this image has a lateral motion with regard to other objects depicted on the ground glass, just as was observed in viewing the objects themselves by ordinary vision or their photographic representatives with the stereoscope. If the left

eye be closed and the head moved slowly in that direction, a faint duplicate image will become visible to the right of the one in question, growing gradually brighter as the motion is continued, the place of which the original image immediately assumes when the right eye is closed and the left opened, but one image again being visible.

With the right eye closed and the head moved to the right, a left hand duplicate image becomes visible, the place of which the right hand one assumes upon again reversing the eyes.

In both these cases, the distinct image is seen by virtue of rays admitted through the opposite aperture to the eye that receives them, and with the axis of which they are brought to coincide. The faint image being the result of rays passing through the other aperture, not distinctly seen until the axis of this eye is in turn brought to coincide with them. The binocular image in front of the ground glass is seen at the point of convergency to which these two images are approaching.

These striking effects, which we have with so much pleasure observed, will entirely vanish by changing the marginal apertures of our camera from a horizontal to a vertical position. By this arrangement we have reduced our lens to an equivalent with a central aperture equal in diameter with the marginal ones; and although objects are seen by rays transmitted through precisely the same apertures as before, we have exchanged lateral for vertical convergency, and this latter does not avail us in the estimation of distances, producing no corresponding convergency of the optic axes.

If, with the apertures restored to their original horizontal position, transparent paper be substituted for ground glass for the reception of the image, the effect will be modified inversely to the degree of transparency to which the paper is reduced, but not, as Mr. Claudet asserts, entirely destroyed.

The mingling of perspectives will be much more conspicuous, each having a greatly increased range of visibility, so that much greater deviation from the line of refraction is requisite to render the images of either aperture invisible. For the same reason, the paper presenting so much greater obstruction to the transmission of the rays of light—no image is visible at the point of convergency of these rays if at all distant from its surface. No other principle appears to exist in transparent paper effecting this result—as Mr. Claudet insinuates when he says that "paper (*i.e.* transparent paper) being perfectly opaque stops all rays on their passage, by which the image remains fixed on its surface"—except the degree of its transparency. Transparency being that property of a medium which presents no obstruction to the rays of light, and which permits rays refracted on its surface to be seen only in the direct line of their refraction, producing no illumination of the surface at the point of contact visible in other directions; partial transparency, however, admits of partial transmission of the rays of light, rendering objects refracted upon a medium possessing it visible not only in the direct line of refraction but in other directions, in inverse ratio to the degree of its transparency, the surface becoming luminous at the point of contact of the incident ray.

To this latter class belong ground glass, transparent paper, so called, &c.

In confirmation of the similarity of these two media with regard to the transmission of light, notwithstanding Mr. Claudet's assertions to the contrary, the writer has observed that when a double thickness of ground glass or a piece coarsely ground is used, the effects peculiar to transparent media are impaired to almost the same extent as when prepared paper is substituted. On the contrary, when prepared paper is used as a medium, all these effects will be preserved in proportion to the degree of its transparency. This should evidently not be the case if "ground glass were perfectly transparent," or if "paper were wholly opaque."

All these experiments tend to establish the possibility of rays of light rendering themselves visible in other directions than the line of refraction when received upon a ground glass; and if further proof were required it would be found in the improved field of the camera when constructed with a combination of lenses, obtained by the introduction of a second ground glass at the focus of the anterior lens. This conclusively proves that more rays now reach the original ground glass in formation of the ultimate image, than reached it before the introduction of the second ground glass, and consequently that the image of the anterior lens is seen through the instrumentality of this second ground glass in other directions than the direct line of refraction of the rays that form it.

The success of these experiments, therefore, greatly depends upon the degree of transparency of the medium used for the reception of the image; and after procuring the finest ground glass for the purpose, the writer has found the best effect produced by slightly oiling its ground surface, a much greater degree of transparency being thus acquired. Under these circumstances the mingling of perspectives is at a minimum, and the least resistance offered to the projected ray. Every object is seen at its proper focal point instead of on the surface of the ground glass, the rays either before or after convergency passing through it unobstructed. Those objects only are now visible on the ground glass which properly belong there, together with the most distant objects of the landscape, whose ray is too feeble to make its way through in a clearly defined image visible at its point of convergency.

Mr. Claudet is not definite as to the manner in which this convergency is produced; whether mechanically by coincidence of similar points of dissimilar perspectives, as in the stereoscope, or naturally by consecutive concentration of the optic axes upon the various points of the image. In the case under consideration, it is evidently in a degree mechanical, inasmuch as it is instituted by the refractive power of the lens exercised upon the rays issuing from the several points of the object and crossing at their focal point, effecting a corresponding degree of convergency of the optic axes when coincident with them. The image nevertheless is seen as in natural vision without the intervention of further mechanical agency.

The writer having passed through these initiatory steps, has further benefited by the suggestions of Mr. Claudet, and constructed the instrument to which the inventor has given the name of Stereomonoscope.

This instrument much resembles both in construction and appearance an elongated camera obscura, the object to be represented on the ground glass being a stereoscopic plate. The lens of the camera is divided into two semi-lenses, one of which has a rotary as well as lateral motion, in order that the images of the plate may be perfectly superposed.

When properly adjusted the resultant image on the ground glass will be seen in perfect stereoscopic relief.

The success of this instrument is entirely dependent upon the principles investigated in the foregoing article.

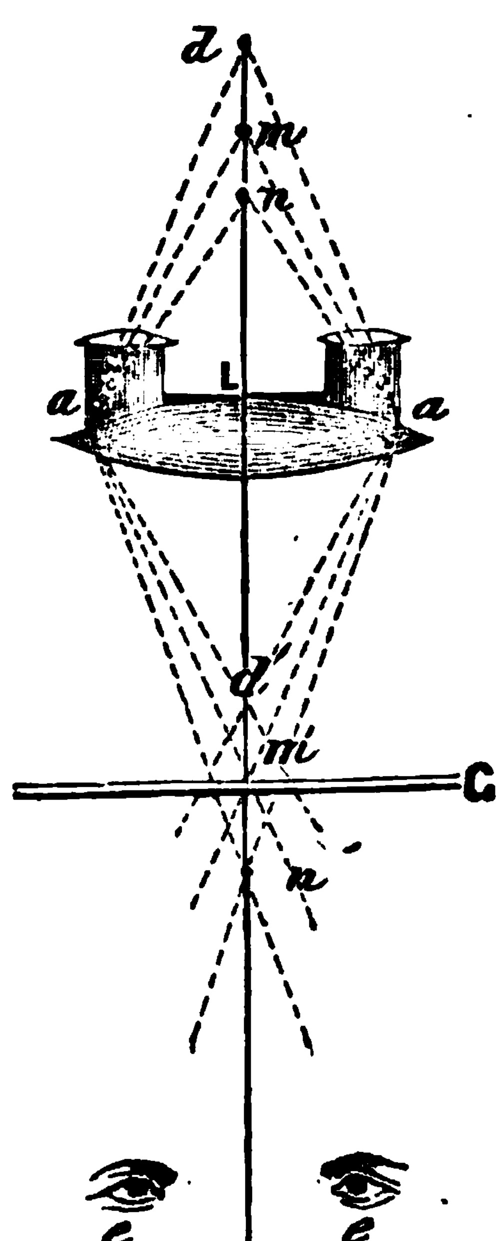
Mr. Claudet naturally supposed that if by refraction of the lens of a camera obscura, two images of an object were so combined upon the ground glass as to produce the stereoscopic illusion, so two separate perspectives of an object might, by the same means, be combined and result in producing a similar effect.

Experiment verified the sagacity of the inference.

The construction and operation of the camera used in the foregoing experiments as well as of the instrument now under consideration, may be better understood by reference to the figures below.

Let *n m d* (Fig. 4) represent near, middle, and distant points of a landscape, and suppose rays issuing from these three points to pass through the marginal apertures *a a* of the lens L of a camera obscura, the remainder of the lens being covered. And let the ground glass G be so adjusted that rays from the middle distance *m* be refracted to a focus precisely upon its surface. It is evident that the more divergent rays from the near point *n* will be more distantly converged at a point *n′* in advance of the ground glass G; while the less divergent rays from the distant point *d* will be converged at a point *d′* behind the ground glass; that these rays, all possessed of different degrees of convergency, will pursue their course, and meeting the eyes at *e e*, will effect a corresponding degree of convergency of the optic axes when coincident with them. The points *n m d* will thus be represented in relief at *n′ m′ d′* respectively.

Fig. 4.

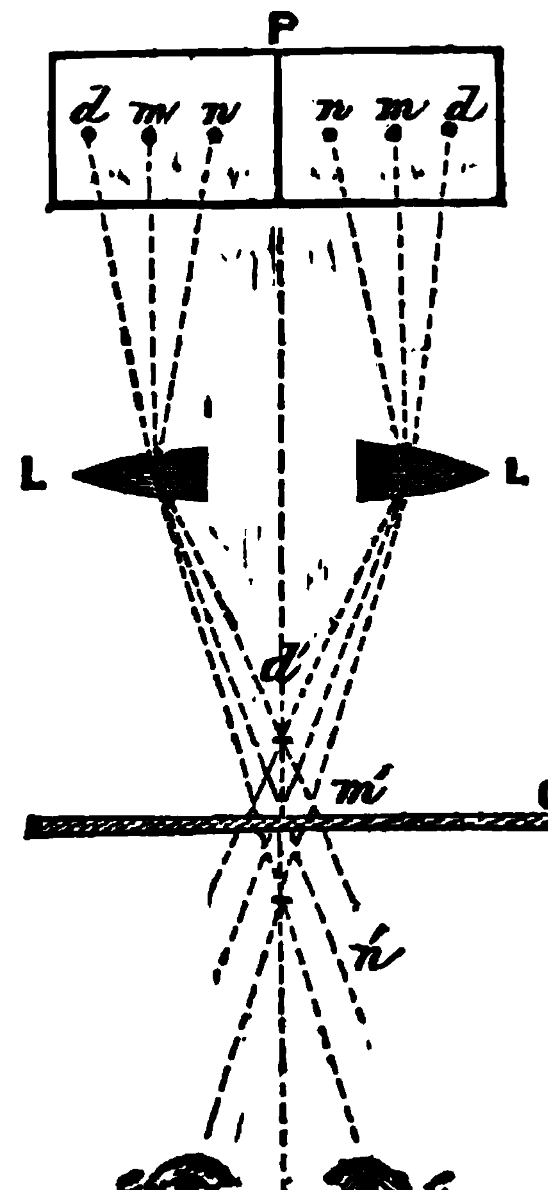


Now, let *n m d*, *n m d* (Fig. 5) represent projections of dissimilar perspectives of these same points upon the surface of the stereoscopic plate P.

Let L L represent semi-lenses so separated that rays from the points of middle distance *m m* shall be precisely superposed on the ground

glass G placed at the focus of the semi-lenses. It is evident that rays from the points *n n*, representing a near point of the landscape and consequently more nearly approached in the perspectives, will fall upon the lenses L L with a greater degree of divergency, and will, consequently, be converged at a more distant point *n′* in advance of the ground glass; while rays from *d d* representing a distant point of the landscape and already possessed of a degree of convergency will be converged at a near point *d′* behind the ground glass; and that all these rays possessed of different degrees of convergency will, as in the previous case, by instituting a corresponding degree of convergeney of the optic axes, be seen in relief at the points *n′ m′ d′* respectively.

Fig. 5.



It may be objected that in these figures rays issuing from the distant points *d* are after refraction, possessed of a greater degree of convergency than those issuing from near points *n*. This, however, is only an imperfection in the diagrams, submitted to in order to avoid confusion with lines crossing one another. It is evident that the rays converged at *d′* as seen in the figures could never reach the eyes as there placed, and that rays converged at that point could meet them only when transmitted through a more central part of the lenses; and further, that the principle upon which the figures are constructed insures by the eyes the reception of no rays from distant points possessed of a greater degree of convergency than those received by them from near points.

In enumerating the advantages of the stereomonoscope over the ordinary lenticular stereoscope, it is suggested that a considerably enlarged image may be thrown upon the ground glass, and that this may be subsequently still further increased by viewing it with a large convex lens.

It is undoubtedly true that the stereoscopic image may be somewhat magnified by the semi-lenses by which it is formed, but certainly not without limit.

It must be remembered that we cannot magnify the images of which it is composed without at the same time magnifying their differences of perspective, and this by increasing the distance between their respective points of convergency, renders that process much more difficult for the eyes to effect. Yet another consequence of this amplification would be to create an appreciable difference between the point of superposition of any two similar points of the perspectives and the focal point of the rays issuing from said points, thus interfering with the distinctness of the resultant image. Add to these objections the

diffusion of light entailed by the process and its consequent enfeebled transmission through the ground glass, and it will readily be understood that there is a most decided barrier to this species of improvement.

With regard to subsequent magnifying of the image by means of convex lenses, a difficulty will also be found; for in this way we likewise exaggerate the coarseness of the surface upon which it is projected. It must, therefore, be admitted that no very great advantages are to be anticipated from amplification.

Neither, as has been insinuated, can the image be satisfactorily seen from a variety of points of view, for in passing the eyes over it slowly it will be observed that instantly as the converging ray from any point is lost to either eye, will that point of the picture lose its relief and recede to the surface of the ground glass.

In convenience and portability likewise does this instrument in no degree approach its rival the stereoscope.

The very exigences of the principle to be developed are antagonistic to the exercise of any great degree of economy of space in its construction.

That made by the writer is furnished with semi-lenses seven inches in focal length. To produce an image equally large with the object, it is necessary that the latter be placed double the focal length in front of the lenses; the image will then be formed an equal distance behind them. We have thus an instrument twenty-eight inches in length, which must further be carefully inclosed so as to exclude all light not directly instrumental in the formation of the image.

We therefore see that in point of convenience or in perfection of result, the stereomonoscope possesses no advantages over the lenticular stereoscope, and is not likely "to produce a revolution in the application of that splendid discovery to the exhibition of photographic pictures."

This, however, in no degree detracts from the credit due its inventor, for as an instrument illustrative of a new principle in optics and suggestive of solutions to many hitherto unrecorded, if not entirely unobserved phenomena, it is worthy of all admiration and its inventor deserving of all praise.

Germantown, October 7th, 1860.

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*The Reaping Machine known to our Celtic Forefathers.**

Truly, there is "nothing new under the sun." A correspondent of the *Gloucester Chronicle* thus writes as to reaping machines:—"It may, perhaps, be interesting to you and to your readers to learn that those 'utter barbarians,' as our British ancestors have been wont to be called, were before us in many of the inventions which are supposed to be the result of modern ingenuity. I am not prepared to say that they had the steam plough, but that they had reaping machines there can be no doubt in the minds of those who read the fol-

*From the London Engineer, No. 241.

lowing much-overlooked passage of Pliny, who wrote between the years 60 and 70 of the Christian era:—

De Messe et Tritico.

Messis ipsius ratio varia, Galliarum latifundiis, valli prægrandes dentibus in margine infestis duabus rotis per segetem impelluntur, jumento in contrario juncto, ita direptæ in vallum cadunt spiciæ.

Of reaping itself there are various methods; in the broad plains of the Gauls, enormous machines with teeth set in a row, placed on two wheels, are driven through the standing corn, a horse being attached to it in a contrary way to the usual mode of attaching horses. Thus the corn, being cut off, falls into the furrow.—*Pliny's Natural History*, *Book* 18, *chap.* 30.

Some question may arise whether we should translate *vallum* as it occurs in the latter part of this sentence differently from the sense given that word at the beginning, *vallus* being a van or machine (see Ainsworth's Dictionary), and *vallum* being a trench or furrow. If we adopt the latter translation, then it follows that our ancestors had already attained that excellence in their machine which was with such difficulty effected in those of modern construction. If, on the other hand, we translate it as the machine itself, then they had accomplished that which our modern inventors have not yet succeeded in, for they must have made the machine not only to reap, but to carry away the corn."

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By CHAS. H. HASWELL, Civil and Marine Engineer.

No. 1.

ELASTICITY AND STRENGTH.

The component parts of a rigid body adhere to each other with a force which is termed *Cohesion.*

Elasticity is the resistance which a body opposes to a change of form.

Strength is the resistance which a body opposes to a permanent separation of its parts.

Elasticity and *Strength*, according to the manner in which a force is exerted upon a body, are distinguished as

1st.—*Tensile Strength*, or Absolute resistance.
2d. —*Transverse Strength*, or resistance to Flexure.
3d. —*Crushing Strength*, or resistance to Compression.
4th.—*Torsional Strength*, or resistance to Torsion.
5th.—*Detrusive Strength*, or resistance to Shearing.

Modulus of Elasticity.

The *Modulus* or *Co-efficient of the Elasticity* of any substance, is a column of the same substance, capable of producing a pressure on its base, which is to the weight causing a certain degree of compression, as the length of the substance is to the diminution of its length; or it is the measure of the elastic reaction or force of any substance.

To ascertain the Extension or Compression in the Length or Height of a Body.

$\mathrm{Q}\,l = \mathrm{E}$. Q *representing the quantity a prism of any substance one inch square and a foot in length, would be extended or diminished by a force or weight f; and l any other length of a prism of like section and substance.*

To ascertain the Modulus of Elasticity.

RULE.—As the extension or compression of the length of any substance is to its length, so is the weight that produced that extension or compression to the result required.

Or, $\frac{f}{\mathrm{Q}} = \mathrm{M}$; M *representing the weight of the modulus in pounds, for a section or base one inch square.*

If W is the weight of the prism of one inch square and one foot in length,

Then $\frac{f}{\mathrm{W}\,\mathrm{Q}} = \mathrm{H}$; H *representing the height of the modulus of elasticity in feet.*

To ascertain the weight which a given column, nearly perpendicular, is capable of supporting, omitting the effect of the weight of the column itself:

$\cdot 8225\,\frac{d^2}{l^2}\,\mathrm{H} = \mathrm{W}$; *d representing the side of the column.*

Illustration.—A column of pine, assuming the height of its modulus to be 9,000,000 feet, one inch square, and 5 feet in length, may begin to bend with the weight of a like column, equal in length to

$$\cdot 8225 \times \frac{1^2}{(5 \times 12)^2} \times 9{,}000{,}000 = 2056\ \textit{feet},$$

or, with a weight of ($2056 \times \cdot 02 \times 12$, *the product of the length and the weight of* 12 *inches*) 493·44 lbs., *omitting the weight of the column itself.*

The Weight of the Modulus of Elasticity of a horizontal bar fixed at one end, is to a weight suspended from its extremity, as four times the cube of the length, to the product of the square of the depth and the depression.

The Height of the Modulus of Elasticity of a bar, supported at both ends, is ·156 of the fourth power of its length, divided by the product of the depression and the square of the depth.

The weight under which a vertical column or bar not fixed at its base may begin to bend, is to a weight laid on the middle of the same bar, when supported at its ends in a horizontal position, nearly in the ratio of ·002 of the length to the depression.

Modulus of Height of Elasticity of various substances, and the portion of it, which, if applied lengthwise to them, would pull them asunder.

SUBSTANCES.	Feet.	Height of the prism which would be severed by its own weight.	Proportion of height of cohesion to elasticity.
Ash, . . .	4,617,000	42,080	109 th
Beech, . .	4,180,000	38,940	107
Brass,—Yellow . .	4,940,000	5,180	954
Brick, .		{ 970 144	
Cane, . .	1,400,000		
Cork, . . .	3,300		
Copper,—Cast .		5,000	
Deal, . . .	8,118,000	55,500	146
Elm, . . .	5,680,000	39,050	146
Fir, . . .	8,292,000	40,500	205
Glass, . .	4,440,000		
Gun Metal, . .	2,790,000		
Hempen Fibres, .	5,000,000		
" Twine, . .		75,000	
Iron,—Cast . .	5,750,000	6,110	941
" Wrought, Swedish, .	9,000,000	19,740	456
" " English,	7,550,000	16,938	446
Ice, . . .	6,000,000	300	20,000
Limestone, . .	2,400,000		
" . .	1,600,000		
" . .	625,000		
Lignum Vitæ, . .	1,850,000		
Larch, . .	5,096,000	42,160	121
Lance Wood, . .	5,100,000		
Lead,—Cast . .		348	
Mahogany, . .	7,500,000		
Marble,—White .	2,150,000	1,542	1394
Oak, . . .	4,150,000	32,900	144
Rosewood, . .	3,600,000		
Slate, . . .	7,800,000	7,300	1068
Steel,—Cast . .	9,300,000	39,455	235
Stone,—Portland . .	1,570,000	945	1789
Tanned Cow's Skin, .		10,250	
Teak, . . .	6,040,000	36,049	168
Tin,—Cast . .		1,496	
Whalebone, . .	1,000,000	14,000	71
Willow, . .	6,200,000		
Writing Paper, . .		8,000	
Yellow Pine, . .	9,150,000		
" . .	11,840,000		

Modulus of Weight of Elasticity of various substances.

Substances.	Weight in lbs.	Substances.	Weight in lbs
Ash,	1,525,000	Cast Iron,	13,000,000 / 17,000,000
Oak,	1,713,600		
Oak,—American	1,958,700		
Yellow Pine,	1,856,400	Steel Wire,	29,500,000
Pitch Pine,	1,252,000	Steel Plates,	42,600,000
Red Pine,	2,142,000	Spruce,	1,244,000
Bar Iron,	28,400,000	Zinc,	13,680,000
Wire,	28,081,000	Brass,	8,930,000
Beech,	1,316,000	Lead,	720,000
Mahogany,—Spanish	1,255,000	Gun Metal,	9,873,000

Tensile Strength.

Tensile Strength is the resistance of the fibres or particles of a body to separation. It is therefore proportional to the number of fibres or particles in the body, or to the area of its transverse section.

The *Absolute Strength* of materials, pulled lengthwise, is in proportion to the squares of their diameters.

Table of the Tensile Strength of Materials.

Power required to tear asunder one Square Inch, in Avoirdupois pounds.

Metals.	lbs.		lbs.
Copper, Wrought	34,000	Iron, Plates, boiler	51,000
Cast, American	24,250	" lengthwise	53,800
Wire	61,200	" crosswise	48,800
Bolt	36,800	" ship	44,000
Gold, Cast	20,000	" lengthwise	47,600
Iron, Cast, Low Moor	14,076	" crosswise	40,600
Clyde, No. 1	16,125	Inferior bar	30,000
" 3	23,468	Lead, Cast	1,800
Calder, No. 1	13,735	Milled	3,320
Stirling, mean	25,764	Wire	2,580
Mean of American, by Major Wade,	31,829	Platinum, Wire	53,000
		Silver, Cast	40,000
Greenwood, American	45,970	Steel, Cast, maximum	142,000
Gun metal, mean	30,232	Blistered soft	133,000 / 104,000
Wire	103,000		
Best bar, Swedish	72,000	Shear	118,000
Russian bar	59,500	Blister	104,000
English bar	56,000	Spring	72,500
Rivets, American	53,300	Puddled	67,200
Mean by Telford	65,520	Plates, lengthwise	96,300
" Brunel	68,992	" crosswise	73,700
" Barlow	56,560	Razor	150,000
English rivets	65,000	Tin, Cast block	5,000
Crank shaft	44,750	Banca	2,122
Turnings	55,800	Zinc, Cast	3,500
Scrap	53,400	Sheet	16,000

WOODS.

	lbs.		lbs.
Ash, .	12,000 16,000	Oak, American white	11,500
Beech, .	11,500	English .	10,000
Box, .	20,000	Seasoned .	13,600
Bay, .	14,000	Riga .	12,000
Cedar, .	11,400	African .	14,500
Chestnut, Sweet .	10,500	Pine, Pitch (Fir), .	12,000
Cypress, .	6,000	Norway .	13,000
Deal, Christiana .	12,400	American White	11,800
Elm, .	13,400	Poplar, .	7,000
Lance Wood, .	23,000	Quince, .	6,000
Lignum Vitæ, .	11,800	Sycamore, .	13,000
Locust, .	20,500	Teak, Java .	14,000
Mahogany, .	21,000	African .	17,000
Spanish .	12,000	Walnut, .	7,800
Maple, .	10,500	Willow, .	13,000

COMPOSITIONS.

	lbs.		lbs.
Gold 5, Copper 1, .	50,000	Copper 8, Tin 1, small bars,	50,000
Brass, .	42,000	Yellow metal,	48,000
" Yellow .	18,000	Silver 5, Copper 1, .	48,000
Bronze, least .	17,698	" 4, Tin 1, .	41,000
" greatest .	56,788	Tin 10, Antimony 1,	11,000
Copper 10, Tin 1, .	32,000	" 10, Zinc 1, .	12,914
" 9, " 1, .	17,250	" 10, Lead 1, .	6,800
" 8, " 1, gun metal,	30,000		

MISCELLANEOUS SUBSTANCES.

	lbs.		lbs.
Brick, well burned .	750	Rope, Manilla .	3200
inferior .	290	Wire .	37,000
Chalk, .	118	Hemp .	6400
Cement, Portland, 6 mos.	414	Mortar, 20 years, .	52
" " 7 "	400	Plaster of Paris, .	72
Glass, Plate .	9400	Slate, .	12,000
Flint .	4200	Sandstone, Fine grain .	200
Green .	4800	Stone, Portland	857
Crown .	6000		1000
Hemp Fibres, .	6400	Hailes .	360
glued together,	9200	Craigleith	400
twisted, ½ to 1 in. dia.	8746	Bath, .	352
1 to 3 "	6800	Cement, Sheppy .	24
3 to 5 "	5345	Harwich .	30
5 to 7 "	4860	Chalk 4, Blue clay 5	70
Ivory, .	16,000	Portland 1, Sand 3	389
Marble, White .	9000	Whalebone, .	7600
Italian .	5200		

Hemp ropes, 1 ton per lb. weight, per fathom.
Wire ropes, 2 tons per lb. weight, per fathom.

Cast iron (Greenwood) at three successive meltings, gave tenacities of 21,300, 30,100, and 35,700 lbs.

Bronze (gun metal) varies in tenacity from 23,000 to 54,500 lbs.

The fibres of woods are strongest near the centre of the trunk or limb of the tree.

Experiments on cast iron bars give a tensile strength of from 4000 lbs. to 5000 lbs. per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended one five thousand five hundredth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended less than the three thousandth part of its length.

The mean tensile strength, then, of cast iron being from 16,000 lbs. to 20,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from one-fourth to one-third of this, or of its breaking strain.

A bar of cast iron will contract or expand ·000006173, or the 162,000ths of its length for each degree of heat; and assuming the extreme range of the temperature in this country, between the shade in winter and the sun's rays in summer, in the Middle States, to be 140° (—20° + 120°), it will contract or expand with this change ·0008542, or the 1157ths of its length.

It follows, then, that as 2240 lbs. will extend a bar the 5500th part of its length, the contraction or extension for the 1157th part, will be equivalent to a force of 10,645ths (4·75 tons) per square inch of section.

Experiments on wrought iron bars give a tensile strength of from 18,000 lbs. to 22,400 lbs. (10 tons) per square inch of its section, as just sufficient to balance the elasticity of the metal; and as a bar of it is extended the ten-thousandth part of its length for every ton of direct strain per square inch of its section, it is deduced that its elasticity is fully excited when it is extended the one-thousandth part of its length.

The mean tensile strength, then, of wrought iron being from 55,000 lbs. to 65,000 lbs., the *Value* of it, when subjected to a tensile strain, may be safely estimated at from three-tenths to one-fourth of this, or of its breaking strain.

A bar of wrought iron will expand or contract ·000006614, or the 151,200th part of its length for each degree of heat; and assuming, as before stated for cast iron, that the extreme range of temperature in the air in this country is 140°, it will contract or expand with this change, with a force equivalent to 20,740 lbs. (9·25 tons) per square inch of section.

The tensile force of metals varies with their temperature, generally decreasing as the temperature is increased.

In silver, the tenacity decreases more rapidly than the temperature; in copper, gold, platinum, and palladium, it decreases less rapidly than the temperature.

In iron, the tenacity is less at 212° than at 32°, and at 392° it is greater than at 32°.

Tensile strength of the strongest piece of cast iron ever tested,—45,970 lbs. This was a mixture of grades 1, 2 and 3 of Greenwood iron, and at the 3d fusion.

Adhesion of Roman cement to blue stone, 77 lbs. per square inch.

Table of Elements connected with the Tensile Resistance of various substances.

Substances.	Tensile Strain per square inch for limit of elasticity.	Proportional elongation for strain of limit of elasticity.	Ratio of strain in column 1 to that causing rupture.
	lbs.		
Oak, . . .	2,856	·00167	·23
Yellow Pine, . .	3,332	·00117	·33
Beech, . . .	3,355	·00242	·30
Wrought Iron, ordinary .	17,600	·00062	·30
Swedish .	24,400	·00093	·44
English .	18,850	·00072	·37
	22,400	·00086	·44
American .	21,000	·00080	·40
do. Wire, No. 9, unannealed	47,532	·00165	·49
annealed	36,300	·00129	·58
Steel Plates, blue tempered	93,720	·00222	·67
Wire, . .	35,700	·00120	·50
Cast Iron, English .	4,000	·00116	·25
American .	5,000	·00149	·25

(To be Continued.)

For the Journal of the Franklin Institute.

Particulars of the Steam Ferry Boat John P. Jackson.

Hull built by O. Burtis, Brooklyn, N. Y. Machinery by William Birkbeck, Jersey City, N. J. Owners, New Jersey Transportation Company.

Hull.—Length on deck, 210 ft. Do. at load line, 210 ft. Breadth of beam (molded), 33 ft. Depth of hold, 13 feet. Do., to spar deck, 13 feet. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 12 ins. Keel, depth, 11. Draft of water, forward and aft, 5 feet 6 inches. Tonnage, 858. Area of immersed section at load draft of 5 feet, 140 sq. feet.

Engines.—Vertical beam. Diameter of cylinder, 45 ins. Length of stroke, 11 feet. Cut-off at one-third.

Boiler.—One—Drop flue, round shell. Length of boiler, 30 feet. Breadth of do., 10 feet. Height do., exclusive of steam chimney, 10 feet. Number of furnaces, two. Length of grate bars, 6 ft. Number of flues, above, 6 of 15½ ins.; in centre, 6 of 15 ins.; below, 2 of 23 ins., 2 of 14 ins. Length of flues, above, 18 ft.; in centre, 15 ft. 10 ins.; below, 17 ft. 10 ins. Diameter of smoke pipe, 4 ft. 6 ins. Height do., 48 ft.

PADDLE WHEELS.—Diameter over boards, 21 feet. Length of blades, 9 feet. Depth do., two of 12 ins. Number do., 18.

Remarks.—This is the largest ferry boat ever built in this section of the country, and is to ply between the City of New York and Jersey City. Date of trial, October, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer John P. King.

Hull built by J. A. Westervelt & Sons. Machinery by Allaire Works, New York. Owners, Spofford, Tileston & Co.

HULL.—Length on deck, 235 ft. Do. at load line, 233 ft. Breadth of beam (molded), 36 ft. 4 ins. Depth of hold, 13 ft. 3 ins. Do., to spar deck, 20 feet. 9 ins. Frames—molded, 15 ins.—sided, 14 ins.—apart from centres, 30 ins. Keel, depth 11. Draft of water, forward and aft, 12 ft. Tonnage, 1740. Area of immersed section at load draft of 12 ft., 371 sq. ft. Masts, two.—Rig, schooner.

ENGINES.—Vertical beam. Diameter of cylinder, 71 ins. Length of stroke, 12 feet. Maximum pressure of steam, 30 lbs. Cut-off—variable.

BOILERS.—Two—Return flue. Length of boilers, 26 ft. Breadth of do., 12 ft. 2 ins. Height do., exclusive of steam chimney, 12 ft. 2 ins. Number of furnaces, 5 in each. Breadth do., 3 ft. ½ in. Length of grate bars, 7 ft. 3 ins. Number of flues, above, 18, below, 15. Internal diameter of flues, above, 8 of 13 ins., 8 of 11 ins., 2 of 10 ins.; below, 15 inches. Length of flues, above, 19 ft. 4 ins., below, 12 ft. 7 ins. Grate surface, 225 sq. ft. Heating surface, 5426 sq. feet. Diameter of smoke pipes, 7 feet. Height of do., 60 feet.

PADDLE WHEELS.—Diameter over boards, 28 feet. Length of blades, 10 feet. Depth do., 12 ins. Number do., 24.

Date of trial, October, 1860. C. H. H.

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*Description of Fryer's Apparatus for Filling Locomotive Tenders with Water.** By MR. JAMES FENTON, of Low Moor.

Dr. Papin, the celebrated French precursor of the many inventions connected with modern steam power, demonstrated, as early as the year 1700, the practicability of raising water by the direct action of steam pressure on its surface; and this system is still adopted with complete success for raising saccharine fluids in most sugar houses throughout the world. The method of filling locomotive tenders with water, where the supply is below the level of the railway, recently invented by Mr. Alfred Fryer, of Manchester, and forming the subject of the present paper, is, in fact, an adaptation of Dr. Papin's simple contrivance of 160 years ago.

The apparatus consists of a wrought iron cylinder of 1500 or 2000 gallons capacity, placed upright beneath the surface of the supply water, which may be from 10 to 120 feet below the level of the rail-

* From Newton's London Journal, August, 1860.

way. To reduce the amount of condensation, the cylinder is surrounded with brickwork, and a space of 2 inches between the brickwork and the cylinder is filled with clay, to prevent any water from getting to the outside of the cylinder. The cylinder contains a wrought iron float, fitting it easily, and sliding on a centre guide-rod. The supply water enters through a self-acting inlet valve, of about 75 square inches area, at the top of the cylinder, and it is discharged from the bottom of the cylinder through a pipe leading to the engine water-crane. A steam-pipe is attached to the top of the cylinder, leading to two pillars placed a few yards distant on each side of the crane, and near the line of rails, and provided with flexible pipes, having bayonet joints for coupling to the locomotive boiler. When a tender is drawn up to be filled, the engine-driver couples one of the flexible pipes to the boiler, and turns on the steam, which, passing into the water cylinder, presses on the float, and forces the water up through the crane into the tender with great rapidity.

To prevent the steam now contained in the upper part of the cylinder from blowing out violently into the atmosphere when the flexible pipe is disconnected, a valve is placed in the top of the pillars, opening inwards, which allows a free passage for the steam to enter the cylinder; but when the pipe is uncoupled, the steam can only escape slowly through a small hole drilled in the valve. A hanging valve is placed between the two branches of the steam-pipe, which prevents the steam entering through one of the pillars, from blowing out direct through the other, instead of passing down into the cylinder. As the steam escapes from the cylinder, a fresh supply of water enters it through the inlet valve, the cylinder being placed below the surface of the supply water. This valve is contained within a well, and the supply water is admitted through a valve and grating, by which it can be stopped back out of the well at any time, for the purpose of examining the inlet valve; or the valve itself can be detached and drawn up to the top of the well, being slidden down to its place upon guide-rods, and secured by long screwed bolts that can be reached from the surface. The float is strengthened against collapsing by circular stays; and a small tube is inserted in it, reaching almost to the bottom, so that if any water should get into the interior of the float through a defective joint, it is expelled through the tube as soon as the pressure of steam is removed from the outside of the float, after filling a tender.

The apparatus is equally applicable when the supply of water is obtained from a reservoir at the foot of an embankment, from a well considerably below the level of the ground, or from running water.

In this plan of raising water by the direct action of steam pressure, it might be expected that the condensation of steam in the water cylinder would be so considerable as to interfere seriously with the working of the apparatus; but it must be borne in mind that the larger the cylinder, the smaller is the extent of surface presented for condensation, in proportion to its contents; and it has been proved by experiment that this is not a serious objection in the size of the present apparatus; while the friction and waste of power involved with the

pumps and engines now in use are obviously saved. In order to ascertain whether a locomotive boiler can afford to lose the amount of steam requisite to raise the water, especially where the lift is from 50 to 60 feet high, a boiler has been constructed of 141 gallons capacity, 69 per cent. of which was filled with water, connected by a flexible tube with a water cylinder holding 131 gallons,—the arrangement being in all respects similar to that already described; the discharge water pipe from the cylinder rose 60 feet perpendicularly, but had valves at various lower elevations. The water pipe was 4 inches diameter inside, and the steam pipe 1½ inches diameter, and the area of steam way in the tap 1·83 square inches. Many trials were made, in each of which 131 gallons of water were raised; the average height of lift being 52 feet, and the average pressure of steam in the boiler 56½ lbs. per square inch. In order to guard against too rapid a generation of steam, and to approximate to the condition of a locomotive when standing at a station, the damper remained closed during each trial. It was then found that the loss of steam pressure in raising the 131 gallons of water 52 feet high, was only 4·2 lbs. per square inch, and the time required, 32 seconds. When the damper remained open, the steam was generated more rapidly than it was used, and the pressure then rose during each trial. Hence, a locomotive just arrived at a station will always have sufficient steam to spare to refill the tender; and this will consequently be effected at the entire saving of the pumping engines, pumps, and buildings at present necessary, while the heavy expenses now incurred of attendance, repairs, and fuel, are dispensed with.

With this apparatus, there is no difficulty in working during frost; the crane and pipes being kept always empty, and the water cylinder below the ice—thus removing the danger of the pipes bursting, and obviating the necessity of keeping them thawed by the application of fires, as in the case of the present water cranes. This is a consideration of no little importance, especially in Canada and other countries subject to severe and protracted frosts. The steam that is condensed in forcing up the water is not entirely lost, as it serves slightly to warm the water which will shortly supply the boiler. It has been computed that the cost in fuel of raising 1000 gallons of water 50 feet high, by this process, is less than one halfpenny; and the plan is therefore recommended by economy, great simplicity, and rapidity of action.

Mr. A. Fryer said, he had been led to this plan by difficulties experienced in raising continually large quantities of saccharine fluids, of a specific gravity of about 1·3, which had to be raised a height of 60 feet, to the top of the sugar manufactory. Cranes were previously used to lift the bags of rough sugar to the top of the building, but this was found to be a slow and expensive process when a large amount had to be conveyed, and pumps were then employed for the purpose; the first process of dissolving the sugar in hot water being performed at the bottom of the building, and the liquid then pumped up to the top; but the pumps were found to be rapidly worn and cut by the large quantity of sand, pieces of cane, and other rubbish that was

mixed with the rough sugar, and no form of pump was able to stand the work. He then tried the direct application of the steam pressure to force up the liquid through a pipe, and found it so completely successful that the plan was adopted for the whole of the work. The dissolved sugar was put in a large close vessel, like a circular boiler, 6 feet diameter, with a delivery pipe 4 inches diameter, extending from it to the top of the building, a height of 60 feet; and steam at 40 lbs. per inch pressure was let into the upper part of the vessel, and, pressing upon the surface of the liquid, forced it instantly up the delivery pipe, the lower end of which reached to the bottom of the vessel inside. The process was effected with great rapidity, the solid refuse lying at the bottom of the vessel being swept clean out, together with the liquid. A quantity of 20,000 gallons per day was regularly raised in this way, and the solid matter carried up besides amounted to several tons per day. The vessel was recharged by condensing the steam in it by a jet of cold water upon the outside, and opening a communication with the vat in which the sugar was dissolved; the vessel then became rapidly filled, and the process of letting in the steam and expelling the contents up the delivery pipe was directly repeated. There was found to be but little waste of steam in this process, although no float was used in the vessel, and the steam was admitted direct upon the surface of the liquid; for a film of boiling water was immediately formed upon the surface of the liquid by the condensation of a small portion of the steam, which acted effectually as a non-conducting diaphragm, cutting off the communication with the colder liquid below, since there was no circulation to convey the heat downwards.

He had also made a trial of the same plan for raising water from a well 65 feet deep upon the works, in which the pump was sometimes under water, so that the valves could not be reached for repairs, and the pump was consequently stopped working; and he had succeeded in raising 100,000 gallons of water per day from the well, by that means. In this case, the rising main from the pumps, which was 18 inches diameter, had a second pipe, 4 inches diameter, inserted within it extending nearly to the bottom, and having a valve at the bottom opening upwards; the space between the two pipes was closed at the top with a steam-tight joint, and steam of 40 lbs. pressure was admitted to it from an adjoining boiler. This steam expelled the water from the space between the pipes, driving it up the centre pipe; and on shutting off the steam, a fresh supply of water entered this space by condensation of the steam, and was again expelled up the centre pipe by repeating the process.

In order to ascertain whether, in the case of filling locomotive tenders, there would be any risk of difficulty from want of sufficient steam in the engine boiler to serve for raising the water, he had tried some experiments with a small boiler disconnected from any other work, raising the water by the steam pressure, from a close vessel up a vertical stand-pipe, which had cocks fixed into the side at different levels, that could be opened successively for discharging the water.

He found that the water was discharged at 60 feet height, with a pressure of steam in the boiler of 27 lbs. per square inch, which was only slightly above the pressure required to balance the column of water. The quantity of steam required was found to be so small, that a supply of water sufficient to fill a locomotive tender was easily raised with the boiler fire checked and the damper kept closed, to correspond with the condition of a locomotive standing at a station. In applying this plan for filling tenders, his object was to employ the power available in the locomotive engine for raising the water direct, instead of requiring the erection of fixed pumping machinery and engine power at each station.

It was thought that the plan possessed many advantages. It had great simplicity, and was free from liability to derangement from frost; the saving also in first cost would be very considerable, where stationary engines had now to be employed for pumping.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM AUGUST 1, TO AUGUST 31, 1860.

Alkalies,—Preservat. of Caustic	John Seiberling,	Philadelphia,	Penna.	14
Amalgamator,	Wm. Gluyas,	San Francisco,	Cal.	7
————	James White,	Bangor,	Me.	28
Ant Trap,	Cottingham & Menefee,	Texana,	Texas,	7
Artificial Legs,	B. W. Jewett,	Gilford,	N. H.	7
Auger,	W. A. Ives,	N. Haven,	Conn.	28
Augers,—Handle Fastenings for	J. M. Hathaway,	City of	N. Y.	21
Bed Bottom,	L. W. Buxton,	Nashua,	N. H.	7
———— Slat,	J. N. Dennett,	Bath,	Me.	21
Bedstead,	Wm. Deckmann,	Canton,	Ohio,	21
————	John Leigh,	Edgefield,	S. C.	7
———— Fastening,	H. T. Smith,	Washington,	D. C.	14
Beehives,	Daniel Arndt,	Zanesville,	Ohio,	21
————	E. S. Bacon,	Albion,	N. Y.	28
————	Wm. Hyde,	Emery,	Ohio,	7
————	Samuel Maitland,	Fort Wayne,	Ind.	28
————	C. Williams,	Weston,	Mo.	28
Bells,—Apparatus for Ringing	James Harrison,	Troy,	N. Y.	28
Belt-shipper,	J. C. Goar,	Monterey,	Cal.	14
Black-boards,—Composition for	J. B. Rowell,	Lynn,	Mass.	7
Blanks,—Machine for Rolling	N. C. Lewis,	Boston,	"	7
Blind Rods,—Wiring	Jacob Coover,	Chambersburg,	Penna.	7
Boiler Tubes,—Drawing	S. J. Perry,	Columbia,	S. C.	21
Books and Paper,—Trimming	Gabriel Utley,	Chapel Hill,	N. C.	7
Boots & Shoes,—Manufacture of	L. R. Blake,	Abington,	Mass.	14
————————	"	"	"	14
Bottles,	J. N. Bodine,	Bridgeton,	N. J.	14
————	John Maurer,	City of	N. Y.	14
————,—Apparatus for Filling	C. A. Gregory,	Poughkeepsie,	"	28
Boxes,—Cutting	C. Sewerkrop,	Louisville,	Ky.	7
Brakes,—Car	H. W. Norvill,	Livingston,	Ala.	21
————,—Carriage	Edward Behr,	City of	N. Y.	7
————,—Railroad Car	Walter Somerville, Jr.,	Mitchell Stat.,	Va.	21
————,—Self-acting Wagon	George Buchanan,	Hickory,	Penna.	28
Bread Slicer,	L. W. Baker,	Marlboro',	Mass.	14
Breast Pumps,—Construction of	J. H. Beadle,	City of	N. Y.	21

Brick Machines, .	W. S. Wallace, .	Americus,	Ga.	28
———— .	Wm. Wood, .	Hartford,	Conn.	14
Burglar Alarm,—Clock and	G. K. Proctor, .	Beverly,	Mass.	7
Butter-worker, .	L. S. Ingraham, .	Grafton,	Ohio,	7
Candle-wicks, .	J. H. Tatum, .	City of	N. Y.	21
Candles,—Machinery for Mould.	Ferdinand Meyrose,	St. Louis,	Mo.	7
Cane-coverers, .	E. H. Angamar, .	New Orleans,	La.	28
Cans,—Exhausting and Sealing	W. Y. Gill, .	Henderson,	Ky.	14
——,—Grooves in Necks of	J. D. Willoughby, .	Petersburg,	Va.	21
Car Register, .	L. H. French, .	Philadelphia,	Penna.	28
—— Seats and Couches, .	David Pennoyer, .	North East,	N. Y.	28
Cars,—Iron .	Richard Montgomery,	City of	"	7
——,—Sleeping .	J. B. Sutherland, .	Detroit,	Mich.	14
Carriages,—Exten. of Seats for	J. A. Naylor, .	Rahway,	N. J.	21
Cattle Ties, .	George Hull, .	Port Crane,	N. Y.	28
Chair Bottom,—Metallic	Volney Stockton,	Williamsburgh,	Ohio,	7
———,—Folding .	J. H. Swan, .	City of	N. Y.	21
Cheese Cutter, .	J. G. Barker, .	Watertown,	Mass.	14
——— Hoops, .	H. A. Roe, .	Madison,	Ohio,	28
Chuck and Counter-sink,	Daniel Argerbright,	Gratis,	"	21
Churn, .	J. M. Buell, .	Zanesville,	"	7
——— .	Hutchins & Leach,	Penobscot,	Me.	14
Clothes Dryer, .	Ransom Gilbert, .	Morrisville,	Vt.	28
———— .	D. K. Hickok, .	"	"	21
———— .	Josee Johnson, .	City of	N. Y.	14
Coal,—Separating Slate from	L. P. Garner, .	Ashland Bor'h,	Penna.	7
Coffee Roaster, .	R. Little, .	Middle Branch,	Ohio,	28
Coloring Matter from Oak Bark,	Carl Henrichs, .	City of	N. Y.	7
Cooking Range, .	E. G. Niles, .	Cincinnati,	Ohio,	21
Cork-drawer, .	Chas. Alexander,	Washington,	D. C.	7
Corn Planters, .	F. G. and E. A. Floyd,	Macomb,	Ill.	28
———— .	J. S. Fowler, .	Peoria,	"	14
———— .	Aaron Miller, .	Brockport,	N. Y.	14
———— .	D. and H. Wolf,	Lebanon,	Penna.	28
———— .	C. L. Waffle, .	Sharon,	Ohio,	21
—— Shellers, .	George Danforth,	Friendsville,	Ill.	21
—— Stalk Cutters, .	J. R. Marshall, .	Marine,	"	21
Cotton Bales,—Fastenings for	J. W. Evans, .	City of	N. Y.	21
——— Gins, .	A. H. Burdine, .	Chulahoma,	Miss.	28
———— .	John Goulding, .	N. Wilbraham,	Mass.	28
——— Presses, .	J. C. Sellers, .	Woodville,	Miss.	28
Couplings for Belts,	Chas. Fairfax, Jr.,	Cincinnati,	Ohio,	21
———,—Car .	R. S. Potter, .	Chicago,	Ill.	28
———— .	L. H. Shular, .	Crawfordsville,	Ind.	7
Coupling,—Hose .	George Hancock, .	Providence,	R. I.	7
Couplings,—Railroad Car	W. H. H. Miller,	Williamsport,	Penna.	28
Crimping Machines, .	David Bissell, .	Detroit,	Mich.	28
Cultivators, .	Thomas Black, .	Princeville,	Ill.	28
———— .	Schuyler Goldsmith, .	Wataga,	"	14
———— .	L. E. Hawkins, .	Sangamon,	"	14
———— .	E. S. Huff, .	Zanesville,	Ohio,	28
———— .	Lewis Leber, .	Springfield,	Ill.	21
———— .	T. W. McDill, .	Oquawka,	"	21
———— .	Mark Rigell, .	Dawson,	Ga.	14
———— .	Jackson Shannon, .	Dakota,	Wis.	14
———— .	Taylor & Graves,	Fort Adams,	Miss.	14
———— .	Ephraim Wells, .	Auburn,	"	28
———— .	Ferdinand Wolf,	Brooklyn,	N. Y.	14
———— .	G. W. N. Yost, .	Yellow Springs,	Ohio,	28
————,—Cotton	J. L. Middlebrooks,	Salem,	Ga.	7
Cupboard and Sink, .	Anthoni Iske, .	Lancaster,	Penna.	7
Cutlery,—Handles for	Matthew Chapman,	Greenfield,	Mass.	7

Decolorizers,—Compounds as	P. M. Belton, .	Brooklyn,	N. Y.	14
Deep Sea Sounding Meter,	J. M. Brooke, .	U. S. N.		7
Distillers Mash Tubs,—Constr.	D. P. Patterson, .	Fayette co.,	Penna.	21
Ditching Machines,	A. S. Ballard, .	Mt. Pleasant,	Iowa,	14
Doors Open,—Holding .	Arthur de Witzleben,	Washington,	D. C.	28
Drain Tiles,—Bottom Plates for	John Parsons, .	Cleveland,	Ohio,	7
Drain Tile Machines, .	Gottlieb Graessle, .	Hamilton,	"	14
Drills,—Rock .	David Ralston, .	Carlisle,	Penna.	21
Elevators for Store-houses,	W. H. Allen, .	Brooklyn,	N. Y.	28
Files,—Machines for Cutting	Wm. Van Anden,	Poughkeepsie,	"	14
Fire Arms,—Projectiles for	Cranston & Bates, .	New London,	Conn.	14
———,—Rammers for Revol.	C. R. Alsop, .	Middletown,	"	7
—— Escape, .	O. F. Burton, .	City of	N. Y.	7
Flasks for Casting Iron Columns,	Henry Demmick,	"	"	21
Flour,—Device for Bolting,	Wm. Halderman, .	Freeport,	Ill.	7
Fodder,—Machine for Cutting	P. S. Clinger, .	Conestoga Cen.	Penna.	14
Foot-scrapers, .	E. G. Burger, .	Ypsilanti,	Mich.	14
Fruit Cans,—Sealing	Cooper & Haller,	Carlisle,	Penna.	7
—— Jars, .	J. C. Baker, .	Mechanicsburg,	Ohio,	14
Furnaces, .	D. T. Woodrow,	Cincinnati,	"	28
———,—Feeding Sawdust to	Samuel Kennedy, .	Hibbetts,	"	28
——— for Heating Buildings	W. H. Churchman,	Janesville,	Wis.	14
Gas,—Apparatus for Compress'g	W. H. Gwynne, .	City of	N. Y.	7
—— Burners, .	A. G. Hamaker, .	Peoria,	Ill.	7
—— Meters, .	Nathaniel Tufts, Jr.,	Boston,	Mass.	14
——— .	Wilson & Fox, .	Reading,	Penna.	21
—— Pipe-cutter, .	Wm. Kenyon, .	Steubenville,	Ohio,	14
Gate, .	H. A. House, .	Brooklyn,	N. Y.	21
—— .	D. E. Fenn, .	Tallmadge,	Ohio,	28
—— .	Wm. McAfee, .	Summerville,	Mich,	21
Gearing, .	A. M. Street, .	Denmark,	Tenn.	14
Girders,—Trussed Compound	J. A. Roebling, .	Trenton,	N. J.	28
Glass Vessels,—Attach. Covers to	R. D. Bryce, .	E. Birmingham,	Penna.	21
—————	Reighard & Knecht,	Birmingham,	"	21
———,—Metallic Covers	John Bird, .	"	"	21
Globe,—Auto. Terrestrial Time	F. S. Barnard, .	City of	N. Y.	28
Glue,—Machines for Cutting	Thomas Brown, Jr., .	S. Danvers,	Mass.	7
——,—Preparation of	J. M. Hunter, .	City of	N. Y.	14
Gold Chains,—Making .	Isaac Lindsley, .	Providence,	R. I.	7
—— Pens,—Rolling	Alexander Morton,	City of	N. Y.	28
—— Washer and Amalgamator	J. C. Dickey, .	Saratoga Spr's,	"	28
Grain Separators, .	N. A. Patterson,	Kingston,	Tenn.	28
Grinding Grain and Apples,	C. B. Hutchinson, .	Auburn,	N. Y.	7
Grubbing Machines,	J. B. Ash, .	Elkton,	Md.	21
Guns,—Cane .	Armenius Davis, .	Shelbyville,	Ind.	21
Hammers, .	Reinhold Boeklen,	Brooklyn,	N. Y.	28
Hand-cuff, .	Wm H. Kimball, .	Augusta,	Me.	7
Harrows, .	M. D. Meriwether,	Denmark,	Tenn.	28
Harvesters, . .	George Farmer, .	Osceola,	Fla.	21
——— .	J. H. Irwin, .	Beardstown,	Ill.	21
——— .	F. H. Manny, .	Rockford,	"	28
——— .	W. S. Stetson, .	Baltimore,	Md.	14
———,—Auto. Rakes for	I. C. Twining, .	Wrightstown,	Penna.	14
———,—Grain	Chas. Marston, .	Viroqua,	Wis.	14
Harvesting Machines, .	J. H. Maydole, .	Eaton,	N. Y.	7
Hat-bodies,—Forming	Wm. Fuzzard, .	Charlestown,	Mass.	7
Heating & Cooking Apparatuses	Edward Conway, .	Dayton,	Ohio,	28
——— Rooms,—Device for	Lewis Newsom, .	Gallipolis,	"	21
Hinges,—Spike for .	Henry Garrett, .	Richmond,	Mo.	7
Horse-shoe Nails,—Machine for	Amos Whittemore,	Cambridgeport,	Mass.	14
Horses Hoofs,—Paring .	Abraham Baker, .	Shenandoah co.,	Va.	7

Insects,—Appa's for Destroying	Adolph Isaacsen,	City of	N. Y.	21
Ink Bottles,—Case for Indelible	Edward Daniels, .	Southampton,	Mass.	7
Iron Bars, &c.,—Rolling	Bernard Lauth, .	Pittsburgh,	Penna.	21
Joists,—Machine for Dressing	J. H. Story, .	Cincinnati,	Ohio,	21
Journal Boxes, .	Montgomery Queen,	Brooklyn,	N. Y.	28
Knitting Machines, .	Walter Aiken, .	Franklin,	N. H.	7
Lamps, .	George Blanchard,	City of	N. Y.	7
——— .	T. B. Smith, .	Marietta,	Ohio,	28
——— .	J. T. Williams, .	York Borough,	Penna.	28
Lanterns, .	T. B. De Forest, .	City of	N. Y.	7
Lathe, .	B. D. Whitney,	Winchendon,	Mass.	7
Leather-splitting Machines,	J. F. Flanders, .	Boston,	"	14
Life-boat, .	Samuel Mills, .	City of	N. Y.	7
Lock, .	Wm. H. Greenwood,	Galva,	Ill.	14
Locom. Engs.,—Dispos'g Sparks	L. P. Teed, .	Wh. Deer Mills,	Penna.	7
————,—Water-heater	S. F. Allen, .	Chicago,	Ill.	7
Lubricator, .	E., B., & T. S. Parker,	Schenectady,	N. Y.	7
Manganese,—Manu. of Oxyd for	C. T. Dunlop, .	Glasgow,	N. Brit.	7
Marking Stock,—Mode of	John Merry, .	Eldorado co.,	Cal.	14
Mattress,—Spring .	Herrmann Jury, .	City of	N. Y.	14
————	Whitehead & Kettle,	"	"	28
Meat and Vegetable Chopper,	L. S. Chichester, .	"	"	28
Metallic Alloy for Journals,	George Sherman,	Memphis,	Tenn.	7
Military Caps, .	J. S. Smith, .	City of	N. Y.	21
Mill,—Grinding .	Daniel Read, .	Hamilton,	"	7
——,—Sugar-grinding .	G. J. Rice, .	Frederick City,	Md.	14
Mills,—Gig .	James Shaw, .	Manayunk,	Penna.	28
—— for Cutting and Grinding,	Evariste Mire, .	New Orleans,	La.	7
——,—Grinding .	P. G. McCulla, .	Philadelphia,	Penna.	14
——,—Portable, .	Nelson Burr, .	Batavia,	Ill.	7
——,—Quartz .	J. C. Davis, .	San Francisco,	Cal.	7
——,—Sugar Cane, .	H. T. Douglas, .	Zanesville,	Ohio,	28
Millstones,—Curb for	O. L. Richardson,	Athens,	Ga.	14
———,—Machines for Pick'g	John Kelly, .	W. Milton,	Ohio,	21
———,———— Dress'g	S. K. Landes, .	W. Cocalico,	Penna.	21
Molding Machine,—Shaping &	H. D. Stover, .	City of	N. Y.	21
Mop-holder, .	B. W. Bruel, .	Beloit,	Wis.	14
Nail Head,—Picture .	J. B. Sargent, .	New Britain,	Conn.	21
—— Plate-feeders,	Wm. Riley, Jr., .	Reading,	Penna.	14
Nails,—Cleansing, &c., Galvan.	Wm. Blake, .	Boston,	Mass.	21
Omnibus Registers,—Self-lock'g	Michael Offley, .	Baltimore,	Md.	7
Ores,—De-oxydizing .	Isaac Rogers, .	N. Haverstraw,	N. Y.	21
Ovens, .	J. M. Read, .	Boston,	Mass.	28
Oxychloride of Lead,—Making	Ludwig Brumlen, .	Hoboken,	N. J.	21
Paddle Wheels,—Fastening for	Ezra Reid, .	Bazetta,	Ohio,	28
Paint Can, .	E. A. Leland, .	Brooklyn,	N. Y.	14
Paper Pulp, .	F. De Compoloro,		France,	7
—— Stock,—Manu. of Leather	E. and J. R. Cushman,	Amherst,	Mass.	21
Pavements, &c.,—Composition	George Scrimshaw,	Milesburg,	Penna.	21
Photographic Camera, .	August Semmendinger,	City of	N. Y.	7
———— Medal,	D. F. Maltby, .	Waterbury,	Conn.	14
Piano-forte, .	Herman Linderman, .	City of	N. Y.	7
———— Keys,	C. J. Schoenemann,	"	"	7
Picture Frames, &c.,—Enamel'g	Robert Marcher, .	"	"	14
Pipes,—Cleansing Galvan. Iron	Wm. Blake, .	Boston,	Mass.	21
——,—Construc. & Joining of	T. S. Truss, .	Darlington,	Engl'd,	21
Planing Machine, .	H. D. Stover, .	City of	N. Y.	21
———,—Cutter-head for rotary	" .	"	"	14
————————	Theodore Christian,	"	"	28

Ploughs, .	J. P. Bond, .	Greenwood,	S. C.	14
——— .	L. D. Burch, .	Sherburne,	N. Y.	14
——— .	Samuel Canterberry,	Holmes co.,	Miss.	14
——— .	J. S. Hall, .	W. Manchester,	Penna.	14
——— .	" .	"	"	14
——— .	A. Roden, .	Talladega,	Ga.	28
——— .	James Smith, .	Norfolk,	Va.	14
——— .	P. H. Starke, .	Richmond,	"	21
——— .	Bancroft Woodcock, .	Williamsburgh,	Penna.	21
——— .	W. E. Wormell,	Germantown,	Tenn.	28
———,—Adjustable Moles for	Lathrop Kazar, .	Leroy,	Ill	14
———,—Hillside	Miller & Henry,	Cincinnati,	Ohio,	21
Post Holes,—Machs. for Digging	A. W. Porter, .	St. Johnsville,	N. Y.	7
Presses, .	L. W. Harris, .	Waterville,	"	28
——— .	A. Roden, .	Talladega,	Ala.	21
Press,—Copying .	C. F. Grabo, .	Boston,	Mass.	14
——,—Cotton .	P. B. Wever, .	Scarborough,	Ga.	21
Presses,—Printing	J. E. Briest, .	St. Louis,	Mo.	28
——— .	G. F. Hebard & others,	Buffalo,	N. Y.	7
———	Wells & Barth, .	Cincinnati,	Ohio,	7
——— .	Thomas Hall, .	St. Louis,	Mo.	7
Propeller for Canal Boats,	Edward Backus,	Rochester,	N. Y.	21
———,—Marine .	G. L. Carver, .	Brazil,	S. A.	7
——— Shafts,—Rollers for	Daniel S. Chase,	Augusta,	Ga.	14
Pruning Trees,—Instruments for	D. P. Chamberlin, .	Hudson,	Mich.	7
Pumps, .	Joseph Hardey, .	Moline,	Ill.	21
———,—Chain, .	Amos Coates, .	Marlborough,	Ohio,	7
——— .	Wm. Shearer, .	Atlanta,	Ga.	21
Quadrants,—Sinecal .	A. M. Chisholm, .	Antigonish,	N. S.	28
Quilting Frame, .	J. L. Newton, .	Black Brook,	N. Y.	28
Railroad Car Springs, .	G. L. Turner, .	City of	"	21
——— Windows,	Messer & Steinbrenner,	Cleveland,	Ohio,	14
——— Cars,—Journal-boxes	Harvey Rice, .	Concord,	N. H.	7
——— Car Wheels,	Walter Youmans,	Waterford,	N. Y.	7
——— Cars,—Stop. & Start.	F. C. Kutt, .	Hackensack,	N. J.	21
———	J. H. Wygant, .	"	"	7
——— Switch,—Safety	H. N. Rhodes, .	Richmond,	Vt.	28
——— Switches,—Operating	Simeon Heywood,	Claremont,	N. H.	28
———	G. K. Hyde, .	Brooklyn,	N. Y.	28
Railroads,—Construction of	Alexander Hay, .	Philadelphia,	Penna.	21
———,—Sliding Switches for	H. N. Rhodes, .	Richmond,	Vt.	28
Railway Bars,—Lock Joint for	Aaron Douglass,	Paterson,	N. J.	21
Rakes,—Horse . .	G. S. Kinsey, .	Reading,	Penna.	28
Reaping Grain & Mowing Grass,	A. A. Henderson,	Huntingdon co.,	"	14
Reaping and Mowing Machines,	"	Philadelphia,	"	14
———	Elizabeth M. Smith,	Burlington,	N. J.	7
Refrigerator, .	D. S. Heffron, .	Utica,	N. Y.	7
Rice,—Machine for Cleaning	James Van Valkinburgh,	Binghampton,	"	21
——,—Machines for Hulling,	C. B. Horton, .	Elmira,	"	28
Rotary Engines, .	H. E. Emery, .	Lincoln,	Ohio,	7
——— .	Cornelius Donovan, .	E. Abingdon,	Mass.	7
——— .	B. A. Goodell, .	Millbury,	"	14
——— .	P. B. Holmes, .	Cincinnati,	Ohio,	28
——— Motion,—Reciprocat'g to	Elisha Matteson,	Brooklyn,	N. Y.	28
Rubber,—Devulcanizing Waste	A. C. Richard, .	City of	"	21
Sack-fastener, .	Thomas Hopkins,	Newport,	Ky.	21
Sad-iron, .	W. M. Knight, .	Buffalo,	N. Y.	28
Sails,—Working Ships	A. L. Simpson, .	Durham,	N. H.	28
Sausage-filler, .	J. G. Perry, .	S. Kingston,	R. I.	28
Saw Blades,—Mach. for Grind'g	Henry Disston, .	Philadelphia,	Penna.	21
——,—Reciprocating .	Christian Germann, .	Camden,	Mich.	21

Saw-set, .	Wm. Clemson, .	Middletown,	N. Y.	21
Sawmills,—Feed Motion for	E. G. Dyer, .	Hamilton,	Ohio,	21
———,—Head Block for	J. W. Truax, .	Richford,	Vt.	28
Saw Teeth,—Mach. for Setting	T. S. and H. Disston,	Philadelphia,	Penna.	28
Saws,—Tempering	Wm. Clemson, .	Middletown,	N. Y.	21
Sawing Stone,—Machines for	A. M. Burnham, .	Montpelier,	Vt.	21
Scaffolds,—Portable	R. M. Lytle, .	Triune,	Tenn.	14
Screw Augers,—Casting	Carl & Heath, .	Grenada,	Miss.	21
Scythe Fasteners, .	C. L. Barritt, .	City of	N. Y.	21
Seaming Machines,—Double	G. R. Moore, .	Pittsburgh,	Penna.	28
Seeding Machines, .	James Alsop, .	Clinton,	Ill.	28
———	Edward Badlam, .	Ogdensburgh,	N. Y.	28
——— .	Wm. S. Lawyer,	Gratiot,	Ohio,	7
———	M. H. Mansfield, .	Ashland,	"	28
——— .	McElroy & Kimble,	Fox Lake,	Wis.	7
Seed Planters, .	Leonard Harriman, .	Anderson,	Ind.	21
——— .	J. P. Allen, .	Dover,	Ga.	14
——— .	T. M. Green, .	Milledgeville,	"	21
——— .	James McLaughlin,	Duncannon,	Penna.	28
——— .	J. R. Mills, .	Bloomfield,	Iowa,	28
——— .	W. F. Schroeder,	La Porte,	Ind.	14
——— .	J. F. Tannehill, .	Staunton,	Va.	14
——— .	Miller Warren, .	W. Middleburg,	Ohio,	21
Sewing Machines,	David Haskell, .	Georgetown,	Mass.	28
——— Machine Needles,	F. H. Drake, .	Middletown,	Conn.	14
Ships Berth,—Oscillating	T. S. Brown, .	Philadelphia,	Penna.	28
Shirt Stud, .	Wm. F. Kubler,	City of	N. Y.	7
Shoe Cleaner, .	Thomas Board, .	Ripley,	Va.	28
—— Pegs,—Mach. for Pointing	S. G. Brett, .	Newport,	N. H.	14
—— Pegging Machine,	C. A. Priest, .	Winslow,	Me.	7
—— Tips,—Cutting & Swaging	Bearce & Peck,	N. Auburn,	"	28
Shutters & Awnings for windows,	Jacob David, .	City of	N. Y.	21
Sofa Bedstead, .	Tendler & Moeshlin,	Cambridge,	Mass.	28
Spading Machines, .	Stuart Gwynn, .	City of	N. Y.	28
Spinning Frames,—Driv. Bands	Slade & Scranton,	Bennington,	Vt.	7
———,—Tubes for	D. D. Allen, .	S. Adams,	Mass.	7
Spoons,—Mach. for Burnishing	H. M. Jacobs, .	Hartford,	Conn.	14
Springs,—Carriage .	G. H. Laub, .	Newark,	Mo.	14
———,—Wagon .	Nicholas Jenkins,	City of	N. Y.	14
Stalk and Root-cutters, .	Frederick Fidler, .	Batavia,	"	28
Steam,—Method of Generating	Stuart Gwynn, .	City of	"	7
——— Boilers, .	G. W. Rains, .	Newburg,	"	14
———,—Low-wat. Alar.	C. H. Brown, .	Fitchburgh,	Mass.	7
——— Engines, .	G. W. Van Deren, .	Big Flats,	N. Y.	14
———,—Condensers	B. F. Lemmon, .	New Albany,	Ind.	7
———,—Governors for	C. P. Buckingham, .	Mt. Vernon,	Ohio,	7
———	R. W. Gardner, .	Quincy,	Ill.	14
———,—Pistons for	H. D. Dunbar,	Memphis,	Tenn.	14
———	Robinson & Clark, .	Bellaire,	Ohio,	14
———,—Slide Valves	L. P. Rice, .	Adrian,	Mich.	28
———,—Valve Gear	Patrick Kenney, .	Providence,	R. I.	14
———	Peter Louis, .	City of	N. Y.	28
——— Gauges, .	Albert J. Allen, .	Buffalo,	"	14
Steering Apparatus,	Nathaniel Snow,	Boston,	Mass.	14
Stop-cocks, .	H. A. Chapin, .	Springfield,	"	21
Stoves, .	Wm. F. George,	Cincinnati,	Ohio,	21
——— .	Magee & Towne, .	Lawrence,	Mass.	14
——— .	J. S. and M. Peckham,	Utica,	N. Y.	7
——— .	J. Stuber and others,	"	"	7
Straw-cutters, .	D. B. Caldwell, .	Cincinnati,	Ohio,	7
——— .	E. D. Lady, .	Nashville,	Tenn.	28
Stump Extractors,	J. B. Lyons, .	Milton,	Conn.	14

Stump Extractors, .	Wm. & Daniel Kimmel,	Cambridge C'y,	Ind.	14
Surveyors Instrument,	Able Ware, .	Athens,	Me.	28
——— Leveling Instruments,	Lorenzo Lea, .	Jackson,	Tenn.	21
——— Measure,	W. H. Paine, .	Sheboygan,	Wis.	7
Sweeping Machine,—Street	Jacob Edson, .	Boston,	Mass.	14
Table,—Circular .	J. F. Finger, .	Marion,	S. C.	24
Tacks,—Applying Washers to	J. G. Howard, .	S. Braintree,	Mass.	28
Tanks,—Construction of Stone	L. B. Darling, .	Providence,	R. I.	21
Tanning,—Compositions for	Alexander Hill, .	Dubuque,	Iowa,	7
——— Apparatus,—Construc.	Dennis Aldrich,	St. Louis,	Mo.	21
Telegraphic Apparatuses,	L. Bradley, .	City of	N. Y.	28
——— Instruments,	David Flannery,	Jackson,	Miss.	21
——— .	E. F. Reynolds, .	West Farms,	N. Y.	21
Telegraphs,—Lightning-arrester	D. F. S. Ways, .	Baltimore,	Md.	7
Tenoning Frame, .	Asa Greenwood, .	Toulon,	Ill.	14
Thills to Vehicles,—Attaching	E. H. Plant, .	Plantsville,	Conn.	14
Thread,—Dressing and Finish'g	Hall & Merrick, .	W. Willington,	"	21
———	" .	"	"	7
Threshing Machines,—Cylinders	L. and E. Whitman,	Winthrop,	Me.	21
Tires,—Machine for Bending	Wm. Bailey, .	London Grove,	Penna.	14
Tire,—Machine for Upsetting	Orlando Foster, .	Kenosha,	Wis.	7
———	Olmstead & Walker,	Victoria,	Ill.	7
———	C. V. Statler, .	Wataga,	"	7
Tool Handles, .	J. G. Rogers, .	San Francisco,	Cal.	14
Trace-fastener, .	Sylvenus Walker, .	Boston,	Mass.	28
Traps,—Animal .	George Slusser, .	Hillsboro',	Ohio,	14
Trap,—Steam .	Nehemiah Upham, .	Norwich,	Conn.	28
Tree Protector, .	W. W. Taylor, .	S. Dartmouth,	Mass.	21
Trunks, .	S. Bourne, Jr., .	City of	N. Y.	7
Trusses,—Construct. of Hernial	L. B. White, .	Moscow,	"	21
Turbine Water Wheels, .	Bradford Stetson, .	Uxbridge,	Mass.	14
Umbrellas, .	J. P. Schenkl, .	Boston,	Mass.	21
Vinegar,—Manufacture of	John Palmer, .	Fort Scott,	Kansas,	7
Washing Machine,	S. T. and David Adams,	Medina,	Ohio,	21
——— .	J. S. Davis, .	Tiffin,	"	14
———	Hugunin & Whitney,	Cleveland,	"	21
——— .	Solomon Hunt, .	Danville,	Ind.	28
———	Patterson & Ramsey,	Kingston,	Tenn.	21
——— .	H. E. Smith, .	Philadelphia,	Penna.	28
———	A. Threlkeld, .	Boone co.,	Ind.	14
Washstand,—Fountain .	J. R. Ender, .	Trenton,	La.	7
Watches,—Lever Escapement	John Devlin, .	Philadelphia,	Penna.	14
Water Elevators, .	Hiram Nash, .	Maysville,	Ky.	7
——— from Wells,—Delivering	James Dakin, .	Cleveland,	Ohio,	21
——— Wheels, .	John Blocher, .	Williamsville,	N. Y.	7
——— .	Adolphus Lind, .	San Francisco,	Cal.	7
——— .	H. G. Nelson, .	Lockport,	N. Y.	28
Wheels for Vehicles,	T. C. Hendry, .	Conyers,	Ga.	7
———,—Holder for Polishing	E. W. Nichols, .	Worcester,	Mass.	7
Willow-peeler, .	J. M. Wood, .	Seneca,	N. Y.	7
Window Shade Fixture, .	R. B. Burchell, .	Brooklyn,	"	7
——— Washer, .	John Middleton,	City of	"	28
Wrenches, .	E. S. Scripture, .	"	"	28
Wrench and Pincers,	Ezra Ripley, .	Troy,	"	14
——— Vise, .	Wm. Russell, .	Stoughton,	Mass.	14

EXTENSIONS.

Brides,—Truss .	Wm. Howe, .	Springfield,	Mass.	28
Screws,—Cutting Wood .	T. W. Harvey, .	City of	N. Y.	28
———,—Wood .	T. J. Sloan, .	Paris,	France,	28

ADDITIONAL IMPROVEMENTS.

Churn, .	M. L. Bauder, .	Cleveland,	Ohio,	7
Lamps, .	Alburtus Geiger,	Dayton,	"	14

RE-ISSUES.

Fire Arms,—Revolving .	J. M. Cooper, .	Pittsburgh,	Penna.	21
—— Plugs, .	J. L. Lowry, .	"	"	21
Gases,—Appa's for Naphthaliz'g	E. H. Ashcroft, .	Boston,	Mass.	14
Hat-bodies,—Mach. for Making	A. B. Taylor, .	City of	N. Y.	21
Lamp Shades, .	Chas. & A. C. Wilhelm,	Philadelphia,	Penna.	21
Shoes,—Wooden-soled	Henry Wight, .	Cambridge,	Mass.	7
Steam Boilers,—Safety Apparat.	Timothy Clark, .	Bedford,	N. Y.	28
Stoves, .	P. N. Burke, .	Buffalo,	"	21
Water from Wells,—Drawing	J. W. Wheeler, .	Cleveland,	Ohio,	21

DESIGNS.

Carpet Patterns (3 cases),	E. J. Ney, .	Lowell,	Mass.	7
———— 8 " .	H. G. Thompson, .	City of	N. Y.	7
Coffins, .	J. P. Cunningham,	Franklin,	Tenn.	14

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, October 19, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Geographical Society.

Donations to the Library were received from the Royal Society, the Royal Geographical Society, the Statistical Society, and the Chemical Society, London; L. A. Huguet Latour, Esq., Montreal, Canada; W. H. Schock, Esq., U. S. Navy, Baltimore, Maryland; Frederick Emmerick, Esq., Washington D. C.; J. Disturnell, Esq., Alfred W. Craven, Esq., City of New York; G. B. Prescott, Esq., Boston, Mass.; and from Messrs. A. L. Elwyn, Francis Wharton, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of September was read.

The Board of Managers and Standing Committees reported their minutes.

Twenty resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (18) were proposed, and the candidates proposed at the last meeting (9) duly elected.

Mr. J. E. Wootten exhibited a model of Andrews and Carr's patent Lubricator for car journals or other end bearings. It consists in introducing the oil for lubrication into a chamber formed by boring a

cylindrical hole into the end of the axle of a depth about equal to the length of the journal. A small hole is bored from the surface of the journal to communicate with the chamber, and through this orifice the oil reaches the bearing. A tube for containing oil fills the chamber. Upon the insertion of this tube with its charge of oil, the chamber is closed by means of an annular screw-plug, in which is inserted a disk of plate glass, which serves the admirable purpose of affording an opportunity of observing at a glance what quantity of oil the chamber contains, and when the supply should be replenished. Experimental tests which have been made with this lubricator, show it to be very economical and efficient in its performance.

A Seed-planter and Horse-rake combined, was presented to the notice of the members. It is patented by Russell & Wiley, of Chester co., Pa., and is claimed to have the following advantages :—

1st. It can be used as a grain drill, sowing, with much accuracy, wheat and oats.

2d. With a little alteration, it is changed to a corn planter, either checkering the grain, or sowing it in one continuous line.

3d. It can be changed in a few minutes time into a horse-rake.

4th. It also has a grass-seed sower attached.

The patentees say, that the machine can be furnished at the same price as an ordinary grain drill.

Mr. Howson exhibited a specimen of Messrs. Dietrich and Bridge's Patent *Hose Protector.* It consists of two sheets of gum elastic or other equivalent flexible material fastened together at one end, the lower sheet being furnished with transverse strips. When a fire occurs in the neighborhood of streets having railways traversed by passenger cars, two of these patent hose protectors are placed one on one rail, and the other on the opposite rail of the track. The upper sheets of the protectors are then thrown back, the lower sheets placed beneath the hose, and the upper sheets folded over the latter. The cars are then allowed to pass over the protectors, which serve to prevent the wheels from injuring the hose or interrupting the flow of water through the same, the direct course of the cars being in no way interfered with. These protectors have been submitted to such practical tests as fully prove their efficiency.

BIBLIOGRAPHICAL NOTICE.

History, Theory, and Practice of the Electric Telegraph. By George B. Prescott. Boston: Ticknor & Fields, 1860.

The subject of this well-written work is one of great interest to an American, not only on account of its practical importance, but because he may legitimately feel proud of the numerous and valuable improvements in it, which are due to his countrymen. The work of Mr. Prescott gives a very good account of the electric telegraph. It contains a very full description of the principal inventions in the art, and these

descriptions are concise, lucid, and abundantly illustrated by excellent wood-cuts. There is every evidence of a disposition to be fair toward all inventors, American and foreign;—so that although we think a very manifest bias against Mr. Morse is shewn, yet we doubt not, it was quite unintentional in the writer. If, however, he believes that Mr. Morse did not devise the local circuit, it would have been more instructive for us, if he had shown us who did and when. But, after all, this bias does not prevent a very fair account of what Morse's Telegraph is, and what Mr. Morse claims, which is all the public generally want to know. The book is of course excellently got up by the publishers, and will constitute a very valuable addition to the libraries of those who want to know the history and the theory of the electric telegraph.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A.M.

September.—The temperature of the month of September was a little more than two degrees below the average temperature for the last ten years, and about half a degree below the average of September, 1859. The daily oscillation, as well as the mean daily range of temperature, was greater than usual.

The warmest day was the 8th, of which the mean temperature was 80·3°. The highest degree indicated by the thermometer was 92°, on the same day. From two o'clock on the afternoon of the 8th, till the same hour on the 9th, the temperature fell 24°.

The temperature was lowest on the night of the 29th, when the register thermometer indicated 42°; and the next day, the 30th, was the coldest day of the month, the average temperature of that day being 48·3°.

The pressure of the atmosphere was greater than usual, the average height of the barometrical column being thirteen hundredths of an inch higher than for September, 1859, and nearly three hundredths of an inch higher than the average for the last ten years.

The barometric column stood highest on the evening of the 30th, when it indicated 30·313 inches, after being reduced to the temperature of 32°. It was lowest on the afternoon of the 25th, when it marked 29·597 inches.

The force of vapor and the relative humidity were again below the average.

There was but one day of the month on which the sky was completely clear or free from clouds, and not one on which the sky was entirely covered with clouds at the hours of observation.

Rain fell at Philadelphia on seven days of the month, to the aggregate depth of 2·907 inches, which is nearly an inch below the average for the month, and five inches less than the amount which fell in September of last year.

The equinoctial storm, visited us in the shape of a heavy shower of rain on the morning of the 20th. It commenced at half past one, and ceased at half past six, during which time an inch and three-quarters of rain fell. Several showers also fell between four and half past ten in the evening, accompanied with thunder and lightning. No damage whatever was sustained at Philadelphia, though the papers from other parts of the country record the destruction of a considerable amount of property by wind and flood. From the 11th till the 14th, a large quantity of rain fell in parts of New York and New England. On the 15th, there was a terrible storm in the Gulf of Mexico, the wind first from the north-west and then from the north, causing the loss of some very valuable merchant ships. At Mobile, the water rose far above the wharves and above the level of the streets, and destroyed a great quantity of merchandize. On the evening of the 19th, another heavy rain storm commenced, and extended from the Hudson River to beyond Lancaster, Pa.

The first appearance of hoar frost observed this season, was on the morning of the 28th.

The winds during the month, as will be seen by the following table of comparisons, were more southerly than usual.

A Comparison of some of the Meteorological Phenomena of September, 1860, *with those of September,* 1859, *and of the same month for ten years, at Philadelphia.*

	Sept., 1860.	Sept., 1859.	Sept., 10 years.
Thermometer.—Highest, . .	92°	82°	95°
" Lowest, . .	42	45·5	39
" Daily oscillation,	18·20	18·10	17·00
" Mean daily range,	5·20	4·10	4·80
" Means at 7 A. M.,	60·28	61·02	62·58
" " 2 P. M.,	73·17	72·88	74·91
" " 9 P. M.,	64·02	64·65	66·63
" " for the month,	65·82	66·18	68·04
Barometer.—Highest, . .	30·313 in.	30·179 in.	30·430 in.
" Lowest, . . .	29·597	29·338	29·338
" Mean daily range, .	·143	·119	·121
" Means at 7 A. M., .	30·003	29·875	29·985
" " 2 P. M., .	29·965	29·835	29 943
" " 9 P. M., .	29·998	29·863	29·961
" " for the month,	29·989	29·858	29·963
Force of Vapor.—Means at 7 A. M.,	·425 in.	·438 in.	·474 in.
" " " 2 P. M.,	·437	·462	·494
" " " 9 P. M.,	·455	·472	·515
Relative Humidity.—Means at 7 A. M.,	77 per ct.	79 per ct.	79 per ct.
" " " 2 P. M.,	50	59	55
" " " 9 P. M.,	72	76	74
Rain, amount in inches, . .	2·907	7·779	3·747
Number of days on which rain fell, .	7	11	8
Prevailing winds, . . .	s. 74°26′ w·397	n. 70°38′ w·236	s. 88°22′ w·220

Abstract of Meteorological Observations for August, 1860 made in Philadelphia, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 60 feet. Prof. J. A. KIRKPATRICK, Observer.

CHAMBERSBURG, Frankl... Lat. 39° 58′ N. Long. 77° ... Height 618 ft. WM. HEYSER...

...MERSET, Somerset Co. ...N. Long. 79° 2′ W. Height ... GEO. MOWRY, Observer.

1860. Aug.	Philadelphia Barometer. [redacted]	Barometer. Mean daily range.	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.	Chambersburg Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity 2 P.M.	Somerset Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per c	°	Inch.	Per ct.	Inch.	Direc.
○ 1	29·875	·245	74·0	19	7·7	·275	27		N W.	29·312	71·0	4·0	·483	56	7·0	·600	65		W.
2	29·972	·097	74·2	25	2·8	·419	35		(var.)	29·407	74·7	6·0	·685	66	6·7	·643	58		W S W
3	29·932	·044	75·3	20½	1·5	·538	46		S E.	29·409	75·7	8·7	·690	70	5·7	·737	69		S.
4	29·809	·123	81·0	24½	5·7	·729	55	0·150	S S W.	29·307	82·0	5·7	·752	53	7·7	·826	57		(var.)
5	29·811	·050	83·0	17	3·3	·520	36		N W.	29·350	83·3	2·7	·796	56	4·3	·813	82	0·489	W.
6	29·884	·074	80·7	21	2·3	·481	35		N E.	29·368	81·3	3·3	·719	58	6·0	·804	66		S S W.
7	29·602	·083	82·8	23	2·5	·616	40		S S W.	29·255	83·7	2·3	·721	63	3·7	·600	59	0·128	S W.
8	29·694	·107	82·2	20	1·3	·702	54	0·007	S W.	29·084	81·0	3·0	·705	55	3·3	·745	64	0·037	W.
☾ 9	29·686	·037	81·8	18	1·0	·567	40		(var.)	29·087	80·7	1·3	·596	45	0·7	·683	56		W.
10	29·733	·047	82·7	23	0·3	·703	45		S W.	29·144	80·0	5·3	·651	46	4·0	·822	62	0·665	W.
11	29·604	·071	71·0	13	11·7	·590	78	0·145	N N W.	29·241	74·7	7·3	·577	64	7·3	·588	74	0·024	W.
12	29·872	·087	74·7	21	4·0	·566	52		N E.	29·261	77·7	3·3	·731	67	5·7	·630	61		(var.)
13	29·711	·161	76·0	18	4·7	·860	77	4·617	(var.)	29·125	69·0	7·7	·586	80	9·3	·436	60	0·580	N W.
14	29·645	·134	65·0	8½	11·0	·524	77	2·140	N W.	29·312	67·0	2·7	·469	62	5·7	·424	64		N W.
15	29·971	·126	67·0	21	3·3	·367	43		N	29·422	66·0	0·7	·572	75	3·7	·389	60		N N E
● 16	30·013	·042	69·0	23	2·0	·382	41		N E.	29·437	69·0	3·3	·577	64	3·0	·456	49		S E.
17	29·941	·072	71·5	24	2·5	·486	46		S W.	29·304	71·0	1·7	·678	73	7·0	·665	56		W S W
18	29·762	·179	75·7	24½	4·2	·671	57	0·270	S W.	29·131	75·7	7·0	·746	64	3·3	·648	54	0·017	W.
19	29·808	·067	78·2	21	2·5	·660	52		(var.)	29·212	76·7	2·3	·762	61	3·7	·747	58		W.
20	29·926	·116	78·3	14½	1·8	·750	62		(var.)	29·292	77·7	1·7	·783	61	1·7	·804	65		S.
21	29·942	·023	76·3	13	2·0	·790	72	0·612	S E.	29·275	77·7	2·0	·718	64	7·3	·635	90	1·340	W.
22	29·914	·027	76·2	15	1·5	·713	63	0·096	(var.)	29·278	73·3	4·3	·731	62	3·7	·627	72	0·047	S E.
☽ 23	29·877	·038	78·5	18	2·3	·728	58	0·149	E.	29·201	75·3	2·0	·768	74	2·3	·619	63	0·017	S S E.
24	29·749	·128	75·7	10½	4·2	·728	73	0·399	E.	29·071	75·3	3·3	·704	73	4·3	·689	57	1·046	W.
25	29·656	·093	78·0	15	3·7	·671	54	0·455	W N W	29·082	73·7	2·3	·660	67	5·7	·667	67	0·194	W.
26	29·750	·095	72·8	17	5·2	·496	50		W N W	29·176	71·3	2·3	·420	52	4·7	·510	63		W.
27	29·795	·045	75·3	22	2·8	·500	43	0·015	S W.	29·169	69·3	4·0	·595	76	2·0	·512	53		W.
28	29·787	·026	68·6	10	6·6	·458	55	0·006	N.	29·177	62·3	4·0	·510	89	9·0	·498	91	0·379	?
29	29·872	·065	67·3	20	3·6	·353	40		N W.	29·270	64·3	4·3	·398	56	5·7	·393	59		N W.
30	29·695	·072	70·2	24	2·8	·481	47		S W.	29·214	68·3	5·0	·541	68	6·0	·448	52		W S W
○ 31	29·692	·203	75·2	21	5·0	·700	63		S W.	29·037	70·7	5·7	·601	65	7·3	·428	51	0·156	W.
Means	29·832	·090	75·4	19	3·8	·584	52	9·260	s81°w	29·270	73·6	3·7	·637	63	5·1	·621	63	5·120	s78°w

Abstract of Meteorological Observations for August, 1860; made in Adams, Dauphin, Northumberland, Centre, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Gettysburg, Adams Co. Lat. 39° 49' N. Long. 77° 18' W. Ht. 624 ft. Prof. M. Jacobs, Obs.				Harrisburg, Dauphin Co. 40°16', N. 76°50', W. Ht., 300 ft. John Heisely, M.D., Obs.					Shamokin, Northumberland Co. 40° 45' N 76° 30' W. Height, 700 ft. P. Friel, Obs.				Fleming, Centre Co. 40° 55' N. 77° 53' W. Ht., 780 feet. S. Brugger, Obs.				Freeport, Armstrong Co. 40° 44' N. 79° 42' W. Height, 1000 feet. J. H. Baird, Obs.		
Aug.	Barom.	Thermom.		Prevail'g winds.	Barom.	Thermom.		Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermometer.		Prevailing winds.
	Mean.	Mean.	Mean daily range.		Mean.	Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean daily range.	
				Direc.	Inch.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
○ 1				N W.	29·779	73·7	5·3		N.	62·0	9·7		W.	66·3	7·7		N W.	62·7	5·0	W.
2				S W.					S.	66·0	7·7		W.	69·7	4·3		(var.)	70·3	7·7	?
3				S.	29·822	78·0			S E.	72·7	11·0		(var.)	70·0	7·0	0·060	(var.)	74·3	4·7	W.
4				S W.	29·670	84·3	6·6		(var.)	82·0	9·3		W.	77·7	7·7	0·350	W.	76·7	4·3	W.
5				(var.)					N.	77·3	4·7		W.	74·3	4·0		W.	75·7	4·3	?
6				(var.)	29·744	86·0			E.	76·7	4·3		W.	77·7	4·0		(var.)	74·3	2·0	?
7				S S W.	29·645	88·3	1·3		(var.)	81·3	5·0		E.	81·0	3·3		E.	75·7	4·3	W.
8				S W.	29·545	86·7	1·7		S W.	80·7	5·3		E.	81·0	4·0		(var.)	76·3	4·7	?
☾ 9				S W.	29·558	84·7	2·0	} 0·727	(var.)	79·0	3·0		(var.)	77·0	4·7		W.	74·7	1·3	?
10				S W.	29·593	84·0	3·3		(var.)	78·7	3·0	0·280	W.	79·0	2·7	0·050	W.	73·3	2·0	?
11				N E.	29·718	74·3	6·3		N.	66·0	12·7	0·662	E.	68·2	10·7	0·350	W.	64·0	9·3	N.
12				(var.)	29·763	75·3	3·7	} 3·046	S E.	69·0	9·0		S E.	70·3	2·7	} 1·250	S W.	60·7	6·3	S W.
13				(var.)	29·592	70·3	6·3		(var.)	66·0	12·7	2·042	S W.	66·3	6·0		W.	62·3	3·7	N.
14				N.	29·768	68·3	3·3		N.	62·7	5·0	1·371	(var.)	62·3	4·0		(var.)	60·7	2·3	?
15				N.	29·913	68·3	2·0		N.	60·0	6·7		W.	61·0	4·7		(var.)	59·7	1·0	N.
● 16				(var.)	29·925	69·0	1·3		(var.)	60·7	3·3		E.	62·0	1·0		(var.)	65·3	5·7	S W.
17				(var.)	29·774	76·7	4·7		(var.)	68·0	7·3		S E.	69·3	7·3		W.	69·0	4·3	W.
18				S W.	29·804	77·3	3·7		(var.)	75·7	6·3	0·690	(var.)	71·3	2·0		W.	73·7	6·0	W.
19				S W.	29·677	79·0	1·7		N.	74·3	2·7		S E.	73·3	2·0		(var.)	72·3	2·3	?
20				S W.	29·763	80·0	1·7		(var.)	76·7	2·3		S W.	76·0	2·7		S W.	76·0	2·7	W.
21				S W.	29·764	79·7	1·7	2·530	S.	77·7	6·0	0·528	S E.	74·7	2·7	0·050	S W.	73·7	2·3	W.
22				S W.	29·749	76·3	3·3	0·124	N E.	74·0	5·7	0·550	(var.)	73·7	1·7		(var.)	72·7	1·0	S E.
☽ 23				S.	29·721	77·7	2·0	0·235	(var.)	76·0	2·0	0·115	E.	72·3	3·3		(var.)	74·3	1·7	N E.
24				S E.	29·625	76·7	1·7	0·069	E.	74·0	2·7	0·042	E.	72·0	3·0	0·225	(var.)	70·0	4·3	N W.
25				(var.)	29·493	76·3	2·3		W.	73·3	0·7	0·172	W.	68·7	5·3	0·290	W.	64·0	6·0	W.
26				N W.	29·624	73·3	3·0		W.	64·7	5·7		W.	67·0	3·0		(var.)	64·7	3·3	?
27				S W.	29·637	75·0	1·7		S W.	66·7	10·0		S E.	68·0	3·0		W.	65·7	1·0	?
28				N N E.	29·656	66·0	3·3	0·146	N E.	59·0	7·7		(var.)	63·3	6·3		W.			N W.
29				N N W.	29·735	66·7	5·3		(var.)	56·7	3·0		(var.)	61·3	4·7		N W.	59·3		N W.
30				S W.	29·710	71·0	4·3		S W.	62·7	6·0		(var.)	62·7	6·0		S W.	66·3	3·3	(var.)
○ 31				W.	29·490	73·7	4·0		(var.)	70·0	10·0		S W.	66·3	11·0		W.	63·0	3·7	N W.
Means	[illegible]	[illegible]	[illegible]	S 67° W	29·692	76·2	3·6	7·627	W 16° N	70·5	6·1	6·665	S 3° W	70·4	4·6	3·225	S 77° W	69·5	4·4	N 65° W.

JOURNAL

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OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

DECEMBER, 1860.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

Report on the Condition of the Niagara Railway Suspension Bridge, 1860. By John A. Roebling, Civ. Eng.

To the Presidents and Directors of the Niagara Falls Suspension, and Niagara Falls International Bridge Companies.

Gentlemen :—After an absence of two years, I have again visited the Niagara Railway Suspension Bridge, and have, during a stay of three days, on the 18th, 19th, and 20th of July, made a thorough examination of the work. I now present to you the following report:

The Niagara Bridge was opened for railway traffic on the 18th of March, 1855; the lower floor for common travel was completed and in use the year previous. The number of trains and trips of single engines, which at the present time pass over the Bridge in twenty-four hours, averages about forty-five. This great traffic accounts for the rapid wear of the rails, many of which require renewal.

After a thorough examination of all parts of the work, I am unable to report any change.

The camber of the floors and the deflection of the cables, as you well know, depend upon the temperature of the atmosphere. The relative level of the floors is the same as it was in 1855.

In order to be better enabled to judge whether the stiffness of the superstructure has been impaired by a five years traffic, I placed a

leveling instrument between the towers on the New York side, and observed the process of gradual deflection caused by five trains.

A train, composed of the engine "Essex," and tender, of 35 tons weight, drawing 10 empty cars, produced a deflection in the centre of	0·462 feet.
A small engine, drawing 2 loaded passenger cars, 1 baggage car, and 1 loaded cattle car, ...	0·510 "
Another light engine, with 5 loaded passenger cars, and 1 baggage car,	0·520 "
The engine "Essex," and tender alone, . .	0·315 "
The same engine returning with 8 loaded cattle cars, each holding 17 to 18 cattle of the largest size, . . .	0·789 "

A short but heavy train, such as the last, when in the centre of the Bridge between the stays, produces the greatest deflection comparatively. A longer train, loaded at the same rate, and extending over the limits of the stays, deflects the work but little more. In proportion, as the ends of the floor are weighed down, the centre is kept up. By comparing the above observations with those of 1855, we discover no essential difference. The great experimental train, which covered the whole Bridge with loaded cars, propelled by two engines, produced a deflection of ten inches. A similar train passed over now will do the same.

The extreme rise and fall of the floor, owing to the contraction and expansion of the cables, amounts to more than two feet. But the cables being at liberty to contract and expand, this process can never affect their strength.

In my report of 1855 I stated the aggregate ultimate strength of the 4 suspension cables at	12,000 tons.
Permanent weight, supported by cables, . .	1,000 "
Tension resulting, . . .	1,810 "
Proportion of permanent tension to strength, . .	1 : 6·63
Tension produced by a train of 250 tons, . .	452 "
Aggregate tension, ...	2,262 "
Proportion of working tension to strength, . .	1 : 5·30

This liberal allowance of strength and freedom from vibration will insure the durability of the cables.

The question has been repeatedly asked, why trains are not allowed to pass over this Bridge at a higher rate of speed than five miles an hour? This limitation is looked upon as a sign of tacitly acknowledged weakness, and has been frequently referred to as a strong argument against suspension bridges for railway purposes.

This matter I discussed in my report of 1855, but I will explain again and more fully. The first great object of this limitation of speed is *safety*. Although it may look somewhat timid in this fast-going age, to see freight trains move at the rate of five miles per hour, and passenger trains at even a less rate, yet when it is considered that this slow speed insures *absolute safety*, no matter what accident may happen to a train—the traveling community ought to be satisfied with this cautious arrangement. What would be gained by a higher speed? Nothing whatever. The Bridge forms a link between two termini, and there is always time to make connections. Passengers will prefer to cross at a slow rate in order to enjoy the splendid scene-

ry during the passage. The track is so constructed as to form a trough of three feet depth between the girders, into which a car or locomotive will instantly drop, the moment it breaks down or leaves the track—provided there is no great headway. Should such an accident happen to a train, the broken-down car, engine, or track, will act as a powerful brake, and will check its motion. When planning the work, absolute safety was made the first condition, and the track has been constructed accordingly. I would also remark in this connexion, that any further addition of fender-pieces to the track, as an additional means of safety, as has been proposed of late, would only prove an unnecessary incumbrance.

A greater speed than five miles per hour for passenger trains should never be permitted for the reasons stated. But should a much heavier freight business have to be accommodated in the future, the speed of freight trains may be increased without injury to the work. All that will be necessary is, to keep the track in perfect order, and to maintain a continuous bearing at the rail joints to prevent concussions. I will further state here, that by an additional expenditure of $20,000, the stiffness of the Bridge may be so far increased as to admit of the highest practicable speed of freight trains, without producing the slightest injurious effect upon the structure. I make this statement deliberately for the information of those professional and unprofessional opponents to suspension railway bridges, who have made it their business to cast doubts upon the permanency of this work. I also expect to demonstrate this when resuming the works on the Kentucky River Bridge, on the Lexington and Danville Railroad, which, when completed, will form a single span of 1224 feet from centre to centre of towers, over a chasm of 300 feet deep.

The wood-work of the Niagara Bridge, being kept well painted, and otherwise well protected, will last forty years and more. The old wooden St. Clair Bridge, at Pittsburgh, Penna., which I removed to make room for a new suspension bridge, recently completed, has stood exactly forty years. All its principal timbers of pine and oak, on removal, were found good and sound. A portion of this material, after being well tarred, has gone into the new suspension floor, and will no doubt render good service for another forty years.

My views of the durability of the cables have undergone no change since 1855; they have only been strengthened by additional experience. This being a subject of great importance and of general interest, I embrace this opportunity to express myself more fully, and thus perhaps to contribute towards a better understanding of the nature of iron.

The fact is well known, that wrought iron under certain conditions will undergo certain radical changes. And so will all kinds of matter. The material universe is not by any means constituted upon the principle of *immutability*. Material existence is but a theatre of change, of breaking down, of reduction, and of reconstruction of the elements of matter. The Egyptian pyramids are even now undergoing a slow process of disintegration. The dry air of that region, slow

in action, is still sure to do its appointed work. And as all human fabrics, being but material constructions, will have to succumb to the same inexorable law, we cannot expect that the Niagara Bridge will form an exception.

Two kinds of changes are known, which will affect the strength of iron and other metals. The one is wrought by the chemical process of oxidation, and can be guarded against effectually, and is so guarded in the Niagara Bridge. All iron and wire within reach, are kept well painted, and thus preserved against rust. The anchor chains and their connexions with the cables, inside of the anchor masonry and in the rock below, after three coats of paint, are protected by the cement grout, which forms a solid envelope, excluding air and moisture.

But aside from the mechanical protection thus afforded, I depend principally, as was explained in my report of 1855, upon the well-known chemical action of calcareous cements in contact with iron. Oxygen has a greater affinity for lime than for iron. So long, therefore, as the cement will combine with oxygen, or, in other words, has not become completely crystallized, which is a very slow process inside of heavy masonry, the iron will be protected. The cement, not exposed to the air, when setting slowly, has a tendency rather to expand than to contract; but suppose there should be cracks around the anchor bars, large enough to admit air and moisture. Water will then find its way through those cracks, but on reaching the iron, will be more or less impregnated with cement, and thus add another protecting coat. The chemical principle, which I have explained here, I apply daily in my factory for the preservation of wire against dampness. I have also carried on direct experiments for a number of years, which have convinced me of the preserving property of calcareous cements in damp situations.

On examining recently the anchor bars of the Monongahela Suspension Bridge at Pittsburgh, built sixteen years ago, I found them perfectly preserved, as far as the cement, in which they are embedded, was removed. To satisfy yourself on this subject, I shall propose in a few years more, to remove the anchor blocks and to examine the upper links of the anchor chains of the Niagara Bridge. It should be remembered, that good cement grout, when not disturbed by any mechanical action or by a current of water, will set perfectly solid, and will become as hard as sand stone in course of time, and without shrinking. The anchor chains of the Niagara Bridge are, in my opinion, effectually guarded against oxidation.

But iron under certain conditions will undergo another change, which is not so well understood, and is indeed as yet a partial mystery. And this fact has been seized upon as an invincible argument against iron bridges generally, and against the Niagara Bridge especially. I refer to the supposed and popularly so-called *granulation* of fibrous wrought iron.

Although this subject has engaged my attention for a series of years, and I have taken pains to obtain correct information, I yet hesitate to express any decided opinions, that would cover the whole

field of investigation. The question at large I consider open yet. This much only I believe to be settled, that good iron will undergo no change in course of time, unless it is acted on by great heat, or is under the influence of strong continuous vibrations under tension.

As an exception to this last proposition, may be cited the case of old anchors and chains, which, after being exposed on the ground or in the ground, a great length of time, had become considerably rusted and reduced in strength. Aside from rusting, magnetic influences were supposed to have been at work in destroying the strength of these irons. But it should be remarked, that none of these cases have been sufficiently well examined to warrant sound conclusions. It is true that the earth forms a great magnet, whose magnetism is maintained by the sun; and that the magnetic condition of all metals is more or less depending upon the great parent magnet. A steel magnet that has lost its power or tension, when buried in the earth, will be restored by its magnetic currents. But how far the cohesion and elasticity of wrought iron may be affected by these currents, we are yet ignorant of. When a bar of iron is drawn apart by a tensile strain, the fractured ends are magnetically excited, and will attract iron filings, at the same time that they become heated. Both phenomena, magnetism as well as heat, will always accompany the forcible rupture of iron, as can be readily ascertained by experiment. The same phenomena are also exhibited when iron is hammered cold, the heat in this case being more apparent than the magnetism.

The cohesion and elasticity of wrought iron, although different properties, appear to be closely related. In speaking of elasticity, I mean the natural elasticity, and not what is produced by the forced process of tempering. And here may be pointed out a marked physical difference between steel and iron. While the hardening or tempering of steel can be carried to almost any degree, that of the latter can not.

Whatever destroys or impairs the elasticity of iron or steel, will also affect its cohesion. And this fact has also a significant magnetic bearing. Tempered or hardened steel possesses more tensile strength than soft steel. Now when tempered steel loses its hardness by annealing, it assimilates nearer to soft iron in its relation to magnetism. Red-hot iron is not attracted by a magnet, while a steel magnet entirely loses its magnetic properties on being heated red hot. Another remarkable fact is, that artificial as well as natural magnets, when *overloaded*, become weakened. And so does the cohesion and elasticity of an iron or steel bar become weakened by overloading.

The limit of elasticity, or of the *recuperating* force, as it might be termed, of iron and steel is generally stated at one-third of their ultimate strength. I am of the opinion that this is much *over*-estimated for soft puddled irons, and *under*-estimated for good hammered charcoal irons, and still more for steel.

The force which holds together the molecules of iron, is termed cohesion. Heat will expand iron, and when applied intensely and continuously, will melt it, and will thus destroy all cohesion, and at

the same time all elasticity and all magnetic tension. It follows, then, that heat of a certain degree is opposed to cohesion and elasticity. And this explains why large masses of wrought iron, when being forged, and thus subjected for a considerable length of time to an annealing process, will, in the centre, become greatly reduced in cohesion and elasticity. The previously existing fibre in the faggots will change into a coarse crystalline texture, because the iron being in a pasty and nearly molten state, and the mechanical effect of hammering being confined to the surface, and not penetrating to the centre, the formation of large crystals will be left undisturbed. Broken car-axles sometimes appear to have undergone a similar change. The fact is, that they generally exhibit a crystalline fracture. But I suspect that many new axles, although manufactured out of fibrous rough-bar, will, when finished and broken *before* they are used, also exhibit a crystalline fracture. In my own practice I have witnessed the fact, that an experienced manufacturer, anxious to satisfy me, did not succeed in manufacturing round bolt of four to five inches diameter out of good fibrous rough-bar, without producing a crystalline texture in the centre. The oftener he piled the iron, the worse the result. On the other hand, I never heard of a failure when the bolt was forged entire under the hammer, out of good and well worked and thoroughly hammered charcoal blooms, their rough ends cut off.

The most fibrous bar iron may be broken so as to present a granular and somewhat crystalline fracture, and this without undergoing any molecular change in the texture. Take a fibrous bar, say ten feet long, but the longer the better, nip it in the centre all around with a cold chisel, then poise the bar upon the short edge of a large anvil, and a short piece of iron, placed eight or nine inches from the edge on the face of the anvil, then strike a few heavy blows upon the nip, so that each blow will cause the bar to rebound, and to vibrate intensely, and the result will be a granular and somewhat crystalline fracture. Now take up the two halves, and nip them again all around, about one or two inches off the fractured ends, break them off by easy blows over the *round* edge of the anvil, and the fibre will appear again. This experiment proves that a break, caused by sudden jars and intense vibration, may show a granular and even crystalline fracture, without having changed the molecular arrangement of the iron. All fibres are composed of mineral crystals, drawn out and elongated or flattened; and the fracture may be produced so as to exhibit in the same bar, and within the same inch of bar, either more fibre or more crystal. But a coarse crystalline bar will, under no circumstances, exhibit fibre; nor will a well worked out fibre exhibit coarse crystals.

My own view of this matter is, that a molecular change, or so called *granulation* or *crystallization*, in consequence of vibration or tension, or both combined, has in no instance been satisfactorily proved or demonstrated by experiments.

I further insist that crystallization in iron or any other metal *can never take place in a cold state.* To form crystals at all, the metal must be in a highly heated or nearly a molten state.

On the other hand, I am witnessing the fact daily, that vibration and tension combined will greatly affect the strength of iron *without* changing its fibrous texture. The cohesion and elasticity of wire and wire rope will be rapidly destroyed by great tension and vibration combined. Whether I shall be able to account for it or not, *there stands the fact.* But what is true of iron wire applies with equal force, and, when all circumstances and conditions are duly proportioned, with even greater force, to larger masses. The extensive opportunities which my pursuits offer, to make experiments and observations on wire and wire rope, authorize a positive expression on this subject. A great deal of fancy speculation has been indulged in of late years on this question of granulation and crystallization, but generally by men whose opinion can have no weight.

Now, while the fact remains that iron and steel will lose their strength by vibration and tension, it is proper to state, also, in this connexion, that this loss of strength bears a due proportion to the extent and duration of the vibration and tension. Wire ropes may lose their strength by three months service, *without* exhibiting much wear; and they may also last ten years, running all the time, and be greatly worn, before their strength is so far reduced as to be unfit to do duty. I will state here, that there are now ropes of my manufacture on the inclines of the Morris Canal, which have run nine years. This great durability is owing to comparative absence of vibration, in consequence of slow speed and good machinery, although a high tension is maintained.

The greater the elasticity and cohesion of the iron or steel, the better it will support vibration and tension, always provided, that the extent of this vibration and the amount of tension are kept within safe limits. Witness, as examples, the durability of watch-springs, piano wire, sofa and wagon springs, &c., &c., &c.

Wrought iron that has become brittle, as, for instance, chain, car axles, wire or wire rope, on being annealed, will have its softness and apparently, also, its strength restored. As far as softness is concerned, this is correct; but in regard to strength, when applied to wire or wire rope or to fine chains, it is a mistake. Soft annealed wire possesses only half the strength which hard wire has, and is without any elasticity. But wire rope without elasticity is worthless; very little work will make it brittle again and worse than before. It is different with heavy chains and with car axles. Made of indifferent material, crystalline or brittle when new, they will be greatly improved by an annealing process at the very beginning; and if this process is repeated from time to time, their lifetime may be prolonged. I maintain that a good car-axle, made of good material, and finished at the proper heat, by hammering or rolling, is stiffer and stronger than the same axle, when again subjected to annealing without hammering or rolling. Annealing restores softness, but at the same time reduces cohesion and elasticity. To restore the iron of a brittle car axle fully, can only be done by a full heat, with hammering or rolling, which of course will reduce its diameter.

The opinion prevails, that a well drawn-out fibre is the only sure sign of tensile strength. This, however, is true only when applied to *ordinary* qualities of bar or rail iron. The fact is different with good charcoal irons and with steel. The greatest cohesion is accompanied by a fine, close-grained, uniform appearance of texture, which, under a magnifying glass, exhibits fibre. The color is a silvery lustre, free from dark specks. The finer and more close-grained the texture, the nearer the iron approaches to steel. Those who are familiar with good Swedish or Norway irons, will support these statements. These facts alone should be sufficient to disprove the erroneous notion that good iron and steel, which should always be granular, will become so only by vibration, and will thereby lose their strength. But it is important to keep in mind the distinction between a fine uniform granular fracture, and a coarse crystalline fracture. Where coarse crystallization appears, there is a want of contact and compactness, consequently of cohesion and strength generally.

Wire cables, car axles, piston rods, connecting rods, and all such pieces of machinery, which are exposed to great tension as well as torsion and vibration, should be manufactured of iron which not only possesses great cohesion, but also a high degree of hardness and elasticity. The best car axles now in use, are those made of soft steel by Krupf, in Germany. This steel is manufactured from the spathic ore or natural steel ore, of the celebrated mines at Muessen in Siegen, Prussia. A correct report on these axles was given to me by one of the Prussian Commissioners of Railways, in whose district Krupf's works are located. They are safe in cold weather and seldom known to break. This proves that soft steel with more of a granular texture than fibre, possesses a much greater elasticity and strength than the best fibrous iron; and it also furnishes another strong proof against the granulation theory, so much credited in this country.

It may be objected that steel is a different metal from iron. But all irons and steels are only so many different alloys of the same metal. There is no essential difference between the two. What constitutes the true chemical and physical difference between the two varieties, is not so clear. The old idea, that steel owes its distinguishing properties to a greater per centage of carbon alone, is no longer maintained. There are not two metallurgists who agree as to the proper per centage of carbon that good steel ought to contain. The ablest chemists who have analyzed iron and steel, from Karsten and Berzelius down to the present day, have not been able to give us a correct analysis of these two metals. Mr. Mushet, Jr., has recently shown that the excellence of steel is depending upon the presence of Titanium, a substance formerly overlooked. But so long as the chemistry of iron and of steel is still without a sure basis, we must fall back upon well discerned empyrical facts.

The capacity of irons to resist vibration and tension differs much in different qualities, and still greater is this difference when the irons are exposed to a very cold temperature. The tubular bridge at Montreal will not last as long as one in Great Britian of the same dimensions,

material, and workmanship, and rendering the same service; and still less than the tubes over the Nile, in Egypt. One hard winter in Canada will be as trying to the structure as ten years are in Great Britain.

In order to examine the fitness of various qualities of iron for the manufacture of wire rope, I undertook, during the hard winter of 1856, at my establishment at Trenton, a series of experiments, when the thermometer was five to ten degrees below zero. The samples for testing, about one foot long, were reduced in the centre to exactly three-quarters of an inch square, and their ends left larger were welded to heavy eyes, making in all a bar of three feet long. Thus prepared, they were thrown outside of the mill, covered with snow and ice, and left exposed for several days and nights. Early in the morning, before the air grew warmer, a sample, inclosed in ice, would be put into the testing machine, and at once subjected to a strain of 26,000 lbs., the bar being suspended in a vertical position, left free all around. A stout mill-hand, armed with a billet of one-and-a-half inches in diameter and two feet long, then struck the sample horizontally a number of blows, hitting the reduced section, as hard as he could. The blows were counted and continued until rupture took place. Care was taken to maintain a tension of 26,000 lbs. during this test, by screwing up the lever, while the sample kept stretching. Other means for producing vibration were attempted, but none proved so effective as the hitting with an iron bolt. I would remark here, that most of these irons would support from 70,000 to 80,000 lbs. per square inch; and that good samples of three-quarters of an inch square, would support a strain of 26,000 lbs. for a whole week, with no visible stretching, provided all vibration and jarring was avoided. But the least jar would produce a permanent elongation.

Without going into the details of these interesting and instructive experiments, I will only state that the number of blows which the different samples resisted, when encased in ice, ranged from three to one hundred and twenty. Inferior qualities of a crystalline texture would break at the third or fourth blow. Good samples of refined puddled bar resisted very well, and went up to sixty blows, while the better qualities of hammered charcoal irons, supported up to one hundred and twenty blows, stretching and drawing all the time. Indeed, it seemed a wire-drawing process on a rough scale. On the tension being reduced to 20,000 lbs., some good samples resisted the almost incredible number of three hundred blows before breaking.

Such qualities of iron may be depended upon for the construction of wire cables and car-axles. They will be safe at the North Pole, while inferior qualities may answer very well in warmer latitudes.

Well observed facts of the durability of irons, when exposed to tension and vibration, are of more value than speculative opinions. I will here record a few more facts, experienced by myself.

In 1844 I removed the old timber aqueduct over the Allegheny river at Pittsburgh, the heaviest work of that description in the United States, consisting of seven spans of one hundred and fifty feet reach. It had stood fourteen years. All the suspension bars taken out of the

old trusses and arches, and originally made of good puddled iron, on being tested and worked up into bolts for the new wire suspension aqueduct, proved of good quality, as good as such irons generally are.

During the great fire at Pittsburgh, in 1845, the old Monongahela bridge, of eight spans, a heavy Burr structure, burned down. I contracted to put up a suspension bridge, and accepted all the old materials, which were not consumed, including about thirty tons of hammered charcoal iron of excellent quality. This iron, after a severe usage for over thirty years, was found so good that I had it all drawn into wire. Every bar was good for 60,000 lbs. per square inch, as strong and tough as it ever could have been before going into the bridge. The old structure was loose and limber, producing considerable vibration on all vertical bars.

On excavating for the southern anchorage between the old wing-walls of the old Monongahela bridge, a number of round bars of one-and-a-quarter inches diameter, about 40 feet long, good puddled fibrous iron was taken up. They had served as tie bars to keep the retaining walls from spreading. Screwed up tight, they had been under ground about twenty-five years, embedded in clay. The outside rust, firmly combined with clay and sand, appeared to have formed a protective coat. At any rate the strength of the iron had not suffered at all from oxidation, its quality was as good as any puddled bar manufactured at the present day.

Last year, while removing the old St. Clair Street Bridge over the Allegheny River at Pittsburgh, to make room for a new Suspension Bridge, since completed, I examined the old iron with considerable interest and care. All this iron had been manufactured about forty-one years ago, and had been the result of the first attempts at puddling ever made west of the Allegheny Mountains. The manufacturer, who is still living, informed me that in those days puddling was not well understood, and that, although the stock was good cold blast charcoal pig, the iron turned out of a highly crystalline texture. It proved so on its fracture, but of a good color, the texture was uniform and not coarse. On being heated and drawn down to half its size, it made a strong fibrous iron; all it wanted was work. There was not one fibrons bar in the whole lot of suspension bars; they were all alike crystalline and brittle in texture. This iron had, from the manufacturer's own testimony, undergone no change; it was as crystalline on the last day as it was on the first. But there was another quality of iron in the same structure. The straps and bolts which connected the chords with the posts and braces, had been manufactured of a good quality of hammered charcoal iron, and a most capital iron it proved after forty years service.

I will also draw attention to those interesting experiments made recently by Mr. Albert Fink, on a number of suspension bars, taken out of his bridges on the Baltimore and Ohio Railroad, for the purpose of testing their strength after seven years service. These tests exhibited a rate of strength which is only possessed by good iron, and led Mr. Fink to the conclusion that seven years wear had not affected the bars.

All irons form alloys of pure iron, mixed with carbon and other impurities. A certain amount of impurities in the shape of good cinder appears to be necessary to impart strength and cohesion to this metal, and also to make it malleable, and to give it welding properties. The purer the iron is, the higher the heat at which it will weld. Compare, for instance, good Swedish iron with common puddled bar. While the latter will weld at a low heat, the former requires a much higher heat. Compare their fracture and color. The good Swedish bar will exhibit either a fine granular appearance or fibre, accompanied by a silvery lustre, showing comparative purity; the puddled bar will be of a dark color, with a graphite lustre, and will show a coarse texture or loose fibre.

During the process of puddling, as well as of blooming, the melted pig-iron is mixed with cinder, and this mixture, which will adhere by cohesion, prevents the formation of large crystals, which is the tendency of pure iron in a molten state. Now by working (bringing to *nature*, as the puddler calls it), this mixing and crystallization is promoted. The subsequent squeezing and rolling of the puddled ball, or the hammering and shingling of the bloom, will have the effect of condensing, laminating, reducing, and drawing out these crystals, at the same time removing and squeezing out the superabundant cinder from between the metallic crystals. Thus the drawn-out fibre is composed of an aggregate of pure iron threads and leaves, enveloped in cinder.

Pure iron as well as very impure iron is weak; the maximum strength and toughness is obtained by a certain mixture of pure iron with carbon and cinder, thoroughly worked and incorporated. When the fibrous and laminar aggregation becomes so dense as to be fit for the manufacture of steel, then are by this very process sufficient impurities expelled, and the greatest degree of cohesion is obtained. Hence strong steel can only be made of strong iron, no matter what chemicals may be administered during the process.

Keeping the above process before our mind, we may now understand why even the best fibrous wrought iron, when exposed to long continued vibration under tension, or to torsion, bending or twisting, must inevitably become brittle, *because the iron threads and laminæ become loosened in their cinder envelopes.* But the cohesion between the iron and its cinder once destroyed, and its strength is gone. Now whether cohesion is the result of magnetic attraction (according to Faraday) or otherwise, this process appears to be purely mechanical. But let the explanation, which is here offered, be correct or not, the fact remains that fibrous iron and all kinds of iron and steel, will be rendered brittle by vibration and tension, or by bending and twisting, *without* undergoing any mysterious change in its molecular arrangement.

It is only within the last one hundred years that wrought iron has become a *necessity* on public and private works. Large structures entirely composed of iron are of a still more recent date. Long experience on a large scale is therefore wanting. But as far as it goes, the opinion is fully sustained, that good iron, not overtaxed by tension and vibration, and otherwise preserved, will prove one of the most durable building materials at our disposal.

The Menai Chain Suspension Bridge, has now stood about thirty-six years, and is still considered a safe work, although it has, for the want of stiffness, on several occasions suffered severely from gales. The old Wire Suspension Bridge, at Friburg, in Switzerland, has been in use about twenty-seven years, but it does not possess enough of strength and stiffness to guarantee its safety much longer in its present state.

It should be remembered that there are many suspension bridges in this country, as well as in Europe, built without any regard to stiffness, and are therefore constantly subjected to vibration, which must greatly limit their durability.

The cables of the Niagara Bridge, on the other hand, are free from vibration, consequently will last as long as the nature of good wrought iron will permit, when subjected to a moderate tension, not exceeding one-fifth of its ultimate strength. This durability I am unwilling to estimate at less than several hundred years.

Iron has emphatically become *the material of the age.* Upon its proper use the future comfort and physical advancement of the human race will principally depend. It will yet be the harbinger of peace, as already it has given us the means of locomotion and of intelligent intercourse. The subject of this paper is therefore of great importance and is entitled to a truthful consideration.

I will close this report by repeating once more, that the cables of the Niagara Bridge are made of a superior quality of material; that they possess an abundance of strength; that they are free from vibration; that they are well preserved and taken care of; and consequently that they may safely be trusted for a long series of years.

Trenton, N. J., August 1, 1860.

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*Water Cisterns in Venice.**

The French Academy of Sciences has received a communication from M. G. Grimaud, on the manner in which the Venetians construct their cisterns, a plan which he thinks might be advantageously introduced on the heights which overlook Paris, and are occupied by large establishments and a numerous population, and which would greatly benefit by them. Venice occupies a surface of 5,200,000 square metres (1300 acres), exclusive of all the great and small canals which intersect it. The annual average of rain is 31 inches, the greater part of which is collected in 2077 cisterns, 177 of which are public. The rain is sufficiently abundant to fill the cisterns five times in the course of the year, so that the distribution of water is at the rate of 16 litres (3½ gallons) per head. To construct a cistern after the Venetian fashion, a large hole is dug in the ground to the depth of about 9 feet, the infiltration of the lagoons preventing their going any deeper. The sides of the excavation are supported by a frame-work made of good oak timber, and the cistern thus has the appearance of a square truncated pyramid with the wider base turned upwards. A coating of pure and

* From the Journal of the Society of Arts, No. 405.

compact clay, 1 foot thick, is now applied on the wooden frame with great care; this opposes an invincible obstacle to the progress of the roots of any plants growing in the vicinity, and also to the pressure of the water in contact with it. No crevices are left which might allow the air to penetrate. This preliminary work being done, a large circular stone, partly hollowed out like the bottom of a kettle, is deposited in the pyramid with the cavity upwards; and on this foundation a cylinder of well baked bricks is constructed, having no interstices whatever, except a number of conical holes in the bottom row. The large vacant space remaining between the sides of the pyramid and cylinder is filled with well scoured sea sand. At the four corners of the pyramid, they place a kind of stone trough covered with a stone lid pierced with holes. These troughs communicate with each other by means of a small rill, made of bricks, and resting on the sand, and the whole is then paved over. The rain water coming from the roofs runs into the troughs, penetrates into the sand through the rills, and is thus filtered into the cylinder or well-hole by the conical holes already described. The water thus supplied is perfectly limpid, sweet, and cool.

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*A Subway in London.**

The Metropolitan Board of Works report that, with a view to the adoption of means for obviating the expense and inconvenience attending the breaking up of the pavement for the repair of mains and pipes, sewers, and other underground works, and in the hope of obtaining valuable data for their guidance in carrying out future improvements, they determined in making the New Covent-garden approach to form a subway under the street for the reception of gas and water mains, electric telegraph conductors, &c.; and on the 31st of July they entered into a contract for the execution of these works, and they are now in hand. They propose to construct under the street an arched subway 7 feet 6 inches in height by 12 feet in width, and also to form arched side passages for house service pipes, together with proper cellarage on each side of the street. In conjunction with the works proper sewers will be built, and convenient arrangements made for drainage.

* From the Lond. Civ. Eng. and Arch. Journal, Oct., 1860.

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*Strength of Building Stones.**

The following table (showing the specific gravity of colonial and other building stones, the force required to crush one-inch cubes, the amount of disintegration caused by the action of sulphate of soda, taking 1000 as an indication of perfect resistance, and the weight per cubic foot) is from Mr. Knight's treatise mentioned in our notice of the Melbourne Houses of Parliament:

* From the London Builder, No. 918.

	Specific gravity.	Crushing force per square inch.	Am't of disintegration.	Weight per cubic foot in an ordinary state.	Weight per cubic foot after four hours' immersion in water.
Colonial Stones.		In lbs.		In lbs.	In lbs.
Darley sandstone,	2350	2118	·800	124 7-16	132
Bacchus Marsh sandstone,	2213	1949	·200	124	133 5-16
Geelong sandstone,	2207	2150	·600	136 11-16	138 10-16
Kyneton sandstone,	2250	—	·600	131 7-16	135 11-16
Kilmore sandstone,	2423	3100	·650	——	——
Bulleen sandstone,	2484	2100	·750	142 9-16	147 4-16
Doncaster sandstone,	2487	3163	·800	——	150
Plenty sandstone,	2455	3200	·500	146 13-16	150 3-16
Portland (western district) limestone,	2503	3065	·700	——	——
Warrnambool limestone, a picked specimen, hardened by salt water,	2438	5035	·800	——	——
Cape Schank limestone,	2500	3550	·600	——	146
Ballan sandstone,	2446	2450	·800	——	——
Keilor sandstone,	2477	1600	·300	145 11-16	149 10-16
Western Port sandstone,	2357	5400	·500	148 8-16	149 5-16
Apollo Bay sandstone,	2473	Tested up to 6720 lbs. without producing any effect. The machine was inadequate to go beyond this weight.	1·000	——	——
Bluestone (basalt),	2625		—	——	163 7-16
Granite from the Plenty,	2655		1·000	——	——
Sienite from Gabo Island,	2652		1·000	——	——
Templestowe clay slatestone,	2600		1·000	——	——
Mount Sturgeon sandstone,	2386		1·000	142 12-16	144
Inter-colonial Stones.					
Pitfield's New Kangaroo Point sandstone from Tasmania,	2207	2956	·900	132 3-16	134 9-16
Kangaroo Point stone, old quarry,	2252	2881	·050	135 5-16	137 2-16
North-west Bay sandstone from Quinn's quarry, Tasmania,	2322	2069	·700	140 9-16	143
Huon River sandstone, Tasmania,	2417	—	·001	——	——
Sydney sandstone,	2237	2228	·300	——	——
Adelaide sandstone,	—	2800	—	——	——
Adelaide marble,	2715	Tested up to 6720 lbs. without effect.	1·000	——	167 5-16
Stones from Europe.					
Fifeshire sandstones, Scotland,	—	1814	·100	128 3-16	136
Bath oolite, England,	2241	1600	·800	124 14-16	126 6-16
Portland oolite, England,	2447	3135	·950	137 2-16	140 9-16
Park Spring sandstone, from near Leeds, G. B.,	2383	Tested up to 6720 lbs. without producing any effect.	1·000	——	148
Caen, Normandy,	2076	1543	·700	134 5-16	136 4-16
Carara marble,	2713	Tested up to 6720 lbs. without producing and effect.	1·000	166	——

Table *showing the Weight required to crush inch cubes of the four Building Stones principally used in Melbourne.*

	Crushing force per square inch when dry.	Crushing force per square inch after four hours immersion in water.	
	In lbs.	In lbs.	
Pitfield's new quarry at Kangaroo Point,	2956	1919	$31\frac{2}{3}$
Pitfield's old quarry at Kangaroo Point,	2881	1428	$50\frac{1}{2}$
Darley,	2118	1260	$35\frac{1}{4}$
Bacchus Marsh,	1949	1073	45

The above results are derived from the average of four samples of each stone in a dry and two of each in a wet state.

Experiments to prove the fitness of the following stones to act as lintels, &c., tried on scantlings 4 by 4 inches, having a span of 4 feet, and the entire weight suspended from the centre:

	Breaking Weight. cwt.	qrs.	lbs.
Fifeshire, Scotland, sandstone,	1	1	26
Bath oolite, English,	2	2	20
Kangaroo Point white sandstone, from Pitfield's new quarry, Tasmania,	2	2	20
Kyneton, Victoria, sandstone,	2	2	21
Kangaroo Point sandstone, Pitfield's old quarry,	2	3	20
Bacchus Marsh sandstone, Victoria,	2	3	24
Darley sandstone, Victoria,	3	0	2
Bulleen sandstone, Victoria,	3	2	0
Doncaster sandstone, near Bulleen,	3	3	20
Geelong, Barrabool Hill, sandstone,	4	2	20
Portland limestone, English,	6	0	20
Park Spring sandstone, from England, near Leeds,	9	3	6
Adelaide marble,	10	1	11
Colonial basalt,	13	0	2
Mount Moriar, near Geelong,	4	3	15

For the Journal of the Franklin Institute.

Description of a New Portable Coffer Dam. By Capt. E. B. Hunt, Corps of Engineers, U. S. A.

[Read before the American Association of Science, at Newport, R. I., August, 1860.]

The use of the coffer dam in laying foundations under water, is among the best established and most reliable resources of the engineering profession, and its application in several classes of cases is well settled. In making studies for certain contemplated constructions at Fort Taylor, Key West, a new style of coffer occurred to me, which I hope soon to apply and which gives rational promise of success.

The first case considered was one of founding wharf and bridge piers on a rock bottom, over which a thin stratum of sand is spread. A set of piers, ten feet square, of solid masonry from the bottom, was first contemplated. For these the style of coffer planned was a strong square frame, with four corner posts, and a sufficient number of wale-courses across the four sides, and framed into these corner posts, to give the stiffness of side-wall necessary for supporting the whole water-pressure. The length of the corner pieces would be such as to give an excess of a foot or more at the top in the deepest water at high tide. The size in plan would have to be such as to give the requisite working space, and might be reduced to fifteen feet square. This frame work being put together, and stayed by a set of diagonal rope tie braces, could be launched and taken to its position, where it would be placed erect and adjusted to be level, using, if necessary, uprights in one or more angles, to bear on the bottom, or to be driven to the rock, and then lashed or bolted to the leveled frame. These angle posts can be sufficiently driven to give security against the force of tides and currents when needed, and also to sustain the weights required to be rested on the top of the frame. The coffer frame being thus fixed in

position, a row of sheet piling of sound, three-inch, hard pine plank remains to be driven to the rock, in contact with the wales, and guided either by two outside timber guides, made to be removable, or by fixed, flat, iron bar guides with the angles smoothed.

Now comes the feature which I suppose to be entirely novel, and which gives a peculiar character to this portable coffer dam. Take strong canvass, and proceed to make up a case or covering for the entire coffer, using two thicknesses of canvass, and interposing a complete coating of mineral or coal tar, so as not only to cause the two canvass layers to adhere to each other thoroughly, but to make a perfectly impervious sheathing. Along the bottom edge of the coffer sheathing, a similar double canvass flap is joined around the whole bottom line, which will lay spread out over the bottom as far as is judged necessary. This breadth of flap will depend essentially on the nature of the bottom. The surface to be thus covered should first be raked clear of sticks, stones, &c., to prevent tearing holes through the flap. The case and flap, water-tight through their whole extent, and having much positive strength to resist pressure, being put on the coffer and surrounding bottom, it only remains to proceed with the pumping, which being actively pushed will rapidly reduce the small enclosed water column. As this goes on, the exterior pressure comes first on the canvass coating, and this in turn rests against the sheeting piles and along the entire surface of the bottom. As the sheeting should be of even thickness with straight edges, the joints will be close and narrow; hence there will be no danger of ruptures from the bridging strain across them. The submerged exterior guides being either removed or formed of iron bars with beveled edges, would create no dangerous strains. To bring the flap more closely to the bottom, a sprinkling of sand or any clean earth might be thrown over it when in place, or the outer edge might be weighted if needful. In case the water should penetrate through the bottom covering layer, even from the outer boundary of the flap, it is only required to scoop out the enclosed sand, and fill in the bottom with a layer of concrete, as is usual in the common coffer, using the *tramis*, a plain wooden trough, or a box with a trip bottom.

It only remains to proceed in building the piers, using the top of the coffer as a platform, and to support the derrick or traveler, the materials being lightered alongside. Should a steam pump be found necessary, this could be worked on board a lighter, by using a flexible pipe, led through the side at the top, or it could be carried through the case and sheathing near the bottom. A series of lashings along the top of the case could be used for fastening it, and buoyed cords attached to the edge of the flap would serve for its manœuvre.

Another mode of treating this case might be preferred for great depths. This is by using a circular coffer made by trimming to the required arc sweeps of three-inch planks, combining them in full circle ribs so as to break joints and fastening with screw bolts. This is merely turning an arch centre into the vertical. Launching one rib, a set of upright struts with draw-bolts would be placed on it, and the second

rib built on them, &c. In some cases this might be superior to the square coffer. The modification of the case and flap would offer no serious difficulty. Various other timber and iron coffer frames might be advantageously used in treating this case.

In the instance first considered, it was desirable not to obstruct the water-way more than was necessary to get the solidity required by a permanent wharf for heavy vessels. A series of these piers giving the requisite supports for the wharf and bridge platforms answered these conditions, and it was supposed that this plan could be used in water of over twenty feet.

The facility with which this portable coffer can be struck and established is its great recommendation. Admit the water, hoist the case, draw the sheeting, and float the frame to its next station, buoying, if necessary, and then all becomes simple repetition. It is a question of judgment or calculation in each case to give the frame-work the stability required for resisting the pressures, currents, and wave actions; as also to decide where the probable violence of waves would make the plan impracticable or injudicious. Judgment must also be used in deciding whether the ruggedness of the bottom makes this plan inapplicable. Sometimes this difficulty would be fully met by throwing around the coffer a covering sheet of fine clay or marl, which will either make the bottom tight, or so cushion it that the flap can be used successfully. When we contrast the simplicity of this coffer and the facility with which it can be established and transferred, with the complex character of the ordinary fixed coffers, or with Stevenson's portable coffer, so limited, comparatively, in its applications and troublesome in erection, it will need but little consideration to perceive the utility of this device in numerous cases of bridge piers and other structures. To extend the above system to larger piers requires only the application of simple well established principles, which every competent engineer would easily make, and which need not be here dwelt upon.

It is likely to find its first application in a sea wall, which will probably be built at Fort Taylor next winter. It is proposed to use in this case a portable coffer of 50 by 12 feet in five compartments of framing, the intermediate submerged cross bars being made movable. The building of the first section of wall will not much differ from the building of a pier, except that the masonry bond at each end must be arranged to provide for the adjoining sections. In walls but little exposed to the sea, the sections can be brought above low water independently by building plain heads and leaving a clear joint. Of course this would not do where the foundation is bad and the load irregular.

To build this second section, the coffer would be re-established as before, except that the end should be arranged to embrace the wall already carried up, and the sheeting should be shaped to close in neatly on its front and rear faces. The case and flap will have to be so altered at this end as to fit the section of the wall, and extend along its front and rear faces for some distance. In the proposed wall, the use of dovetailed header and stretcher courses of granite is contemplated for the face, and a massive concrete filling for the back. The box planking for

the concrete can rest against the main uprights and can be recovered on striking, thus leaving all the spare space in the coffer for face work.

The simplicity of this coffer and the facility with which it can be shifted from section to section of a sea wall, lead me to believe that it will be found a great source of economy in constructing the walls of wharves, basins, docks, &c., when the shelter from waves and the character of bottom make it available. In many cases the flap could be nearly omitted, and in some rough bottoms the simple coffer case could be used and a slight foot slope of puddle or earth, which works tight, could be thrown in so as to serve the purpose.

This device not having yet been tried, I should scarcely bring it before the public, except that I am willing by publication at once to prevent patents and to give to engineers the benefits it offers, which can be seen beforehand with almost absolute certainty.

For the Journal of the Franklin Institute.

Expansion of Steam.

At a late meeting of the American Engineers' Association, New York City, the subjoined paper was read by its author, Mr. Louis Koch, Mechanical Engineer. E. B.

New York, Nov. 14, 1860.

QUESTION.—*What is the pressure of steam in the cylinder at the end of the stroke when cut off at half stroke?*

This question is easily answered by the experimental tables laid down by the Committees of the French and the Franklin Institutes, by Dr. Lardner, and many others, showing the total pressure in pounds, the corresponding temperature, the volume of steam compared to the volume of water that has produced it, and the mechanical effect of a cubic inch of water evaporated in pounds raised one foot; all of which show conclusively that the pressure of steam in the cylinder at the end of the stroke, when cut off at half stroke, is *not* one-half of its full pressure, and that this difference becomes greater, first, with the increase of pressure, and, secondly, with the decrease of cutting off; all this is strictly theoretical, without regard to friction or the influence of the atmospheric pressure.

The following are a few examples taken from Dr. Lardner's table:

Volume of Steam.	Temperature.	Pressure.	Double Volume.	Corresponding Pressure.	Difference.
1281	228·5	20 lbs.	2562	about 9½ lbs.	½ lbs.
2426	192·4	10 "			
679	269·1	40 "	1358	19·2 "	·98 "
1281	228·5	20 "			
470	295·6	60 "	940	28·03 "	1·97 "
883	251·6	30 "			
362	315·8	80 "	724	37·3 "	2·97 "
679	269 1	40 "			
295	332·0	100 "	590	46·34 "	3·36 "
554	283·2	50 "			

There can be no doubt of the existence of a fixed relation between the temperature and pressure of steam by immediate evaporation when it has received no heat except that which it takes from the water, but that relation is not known, and, therefore, empyrical formulæ have been proposed, which express, with more or less precision, this relation in different parts of the thermometrical scale.

Mr. Southern proposes the annexed, when the pressure does not exceed one atmosphere:—

$$P = 0{\cdot}04948 + \left(\frac{51{\cdot}3 + T}{155{\cdot}7256}\right)^{5{\cdot}13}$$

$$T = 155{\cdot}7256 \times \sqrt{P - 0{\cdot}04948} - 51{\cdot}3$$

Tredgold proposes, when the pressure is from one to four atmospheres:—

$$P = \left(\frac{103 + T}{201{\cdot}18}\right)^{6} \qquad T = 201{\cdot}18\ \sqrt[6]{P} - 103$$

Dulong and Arago propose, when the pressure is from four to fifty atmospheres:—

$$P = (0{\cdot}26793 + 0{\cdot}0067585\ T)^{5} \qquad T = 147{\cdot}961\ \sqrt{P} - 39{\cdot}644.$$

Other formulæ are given by Biot, Taylor, Gay Lussac, &c.

The same uncertainty exists in the relation between the pressure and the augmented volume, and recourse has also been had to empyrical formulæ, of which two, as the most convenient for low pressure engines of every form as well as for high pressure engines on the expansion principle, are given.

Dr. Lardner proposes

$$V = \frac{3875969}{164 + P'}. \qquad V = \text{volume per number of cubic inches.}$$

A more accurate formula, when not less than 30 lbs. per square inch is used, is the following:—

$$V = \frac{4347826}{618 + P'}. \qquad P = 1 \text{ lb. per square foot.}$$

It is well to remark here, in relation to temperature, upon the well known fact that the sum of the sensible and latent heats is a constant quantity; if water at 32° temperature is converted into steam under a pressure of one atmosphere, or 14¾ lbs. per square inch, it is necessary to give it first 180° additional sensible heat, and afterwards 990° of latent heat, making a total of 1170° of imparted heat and 32° of contained heat, or 1202° in all. Should the pressure be two atmospheres, the sensible heat would be augmented to 250°, and the latent heat decreased to 952°; at three atmospheres, respectively 275¼° and 926¾°, and thus continuing, the sensible augmenting and the latent diminishing, as the pressure increases, the constant total being 1202° F., 1170° of which are necessary for the evaporation of ice-cold water, which, consequently, would be raised to the temperature of 1202° if evaporation was prevented.

A very easy mode of calculating the volume of steam under higher temperature than that of one atmosphere is the following:—

1. It being known that air expands with every degree Centigrade, to 1-270ths of its primitive volume at 0° C., it follows that 270 cubic feet of air when heated from 0° to 100° C., will expand to 370 cubic feet, and that 1 cubic foot of air of 100° C. heated with further (t) degrees will become

$$\frac{370+t}{370} \text{ cubic feet.}$$

2. It being known that steam expands agreeably to the same law, it follows that steam of 100° C. if its temperature is increased 21·4° C. will increase to

$$\frac{370+21{\cdot}4°}{370}=\frac{391{\cdot}4}{370} \text{ cubic feet;}$$

therefore, steam from 1 lb. of water, or 1691 cubic feet, will have a volume of

$$\frac{391{\cdot}4}{370}\times1691=1789{\cdot}078 \text{ cubic feet.}$$

3. And as it is, lastly, known that at the same temperature, the pressure of elastic fluids is proportionate to its density, and as saturated steam at 121·4° C. has just double the pressure (or that of two atmospheres), it follows that the before mentioned 1789·078 cubic feet must have double the density, and, therefore, a volume of 894·539 cubic feet.

Having now conclusively proved that the volume of steam increases with the pressure, it follows that there is a decrease of volume with the decrease of pressure, and it is, therefore, evident that the mechanical effect of steam when cut off at any part of the stroke will not be fully one-half of that of its expansion; all this is nothing new, as many tables have been laid down to this effect, as noted above, but as a basis for further calculations on the advantage or disadvantage of cut-offs generally they are valuable.

Now, let us see if there is an advantage in practice by cutting-off steam at any part of the stroke. We will select a bore of cylinder of 200 inches area, or about 16 inches in diameter and 6 feet stroke. We have, at first, to contend with friction and atmospheric pressure at the exhaust; the first of these (friction) is the most difficult to find a basis for, but it being generally conceded that 2½ lbs. per square inch is sufficient in a well built engine, we will take that as a standard.

The atmospheric pressure at the exhaust is the same in both cases, and in relation to the quantity to be discharged, what is less in one case is made up by velocity in the other. It is to be remarked that when, according to the indicator, we work under 50 lbs. pressure, we actually have 64¾ lbs. on the piston (theoretically), the difference of pressure in the boiler and that exerted upon the piston, we will omit, being in both the same, if any, as has been asserted. Let us take 60 lbs. total pressure on the piston, and then find the mechanical effect

in following full stroke and cutting-off at one-half, one-third, and one-quarter stroke.

The mechanical effect of full stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches, or .	72,000 lbs. lifted 1 ft.
Deducting for friction $2\frac{1}{2}$ lbs. per square inch equals 500 lbs., or 3000 lbs. lifted one foot, and atmospheric pressure $14\frac{3}{4}$ lbs. per square inch equals 2950 lbs., or 17,700 lbs. lifted one foot . . . =	20,700 " "
and there remains a clear effect of	51,300 lbs. or $71\frac{1}{4}$ per c.

It has often been asserted that 85, 90, and 95 per cent. mechanical effect has been obtained, but this is decidedly an error, as the pressure was calculated agreeably to the indicator; the indicator in this case would only show $45\frac{1}{4}$ lbs. at 200 square inches equals 9000 lbs., or 54,300 lbs. lifted one foot, thus presenting a mechanical effect of nearly $94\frac{1}{2}$ per cent., which is a deception.

The mechanical effect of cutting-off at one-half stroke will be 60 lbs. per square inch or 12,000 lbs. per 200 square inches; 3 feet stroke equals 36,000 lbs. lifted one foot; at the end of the stroke, as has been seen, we have 28·03 lbs. pressure, and, therefore, a mean pressure of 44·015 lbs. per square inch, or 8803 lbs. per 200 square inches; 3 feet stroke equals 26,409 lbs. lifted one foot; adding as above, we have 36,000+26,409 lbs.=62,409 lbs. lifted one foot. Deducting the foregoing friction and atmospheric pressure, 20,700 lbs. lifted one foot, and there remains a clear mechanical effect of 41,709 lbs. lifted one foot, or 57·93 per cent., with half the amount of steam, or 83,418 lbs. lifted one foot, with full steam, being nearly 116 per cent. (115·86 per cent.)

The mechanical effect of one-third stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches; 2 feet stroke =24,000 lbs. lifted one foot; we have, as seen at the end of the stroke, 19·2 lbs. pressure, and, therefore, a mean pressure of 39·6 lbs. per square inch, or 7920 lbs. per 200 square inches; 4 feet stroke equals 31,680 lbs. lifted one foot; adding as above, we have 24,000+31,680=55,680 lbs. lifted one foot. Deducting friction and atmospheric pressure 20,700 lbs. lifted one foot, and there remains a clear effect of 34,980 lbs. lifted 1 foot, or 48·53$\frac{1}{3}$ per cent, with one-third the amount of steam, or 104,940 lbs. lifted one foot, with full steam, being $145\frac{3}{4}$ per cent.

The mechanical effect of one-quarter stroke will be 60 lbs. per square inch, or 12,000 lbs. per 200 square inches; $1\frac{1}{2}$ feet stroke = 18,000 lbs. lifted one foot; at the end of the stroke, we will have 13·19 lbs. pressure, or a mean pressure of 36·595 lbs. per square inch, or 7319 lbs. per 200 square inches; $4\frac{1}{2}$ feet stroke = 32,935·5 lbs. lifted one foot; adding as above, we have 18,000 + 32,935·5 = 50,935·5 lbs. lifted one foot. Deducting friction and atmospheric pressure, 20,700 lbs. lifted one foot, and there remains a clear effect of 30,235·5 lbs. lifted one foot, or nearly 42 per cent., with one-quarter the amount of steam; or 120,942·0 lbs. lifted one foot, with full steam, being 168 per cent.

Again; let us see if the same proportions exist in a smaller cylinder, shorter stroke, and the same pressure; we will select an area of 50 ins., or about 8 ins. in diameter, 4 ft. stroke, and 60 lbs. pressure.

1st. The mechanical effect of full stroke will be 60 lbs. per square inch, or 3000 lbs. per 50 square inches: 4 feet stroke . = 12,000 lbs. lifted one foot.

Deducting for friction $2\frac{1}{2}$ lbs. per square inch = 125 lbs., or 500 lbs. one foot, and atmospheric pressure $14\frac{3}{4}$ lbs. per square inch = 737·5 lbs., or 2950 lifted one foot = 3,450 " "

And there remains a clear effect of . 8,550 " "

or $71\frac{1}{4}$ per cent.

2d. The mechanical effect of cutting off at half stroke, will be 60 lbs. per square inch, 3000 lbs. per 50 square inches: 2 feet stroke = 6,000 lbs. lifted one foot.

44·015 lbs. mean pressure per square inch, or $2200\frac{3}{4}$ lbs. per 50 square inches: 2 feet stroke . . = $4,401\frac{1}{2}$ " "

Adding, we have . . $10,401\frac{1}{2}$ " "

Deducting friction and atmospheric pressure . = 3,450 " "

And there remains a clear effect of . $6,951\frac{1}{2}$ " "

or 57·93 per cent. with half the amount of steam, and 13,903 lbs. lifted one foot, or 115·86 per cent. with full steam.

3d. The mechanical effect of cutting off at one-third stroke will be 60 lbs. per square inch, 3000 lbs. per 50 square inches: $1\frac{1}{3}$ feet stroke = 4000 lbs. lifted one foot.

39·6 lbs. mean pressure per square inch, or 1980 lbs. per 50 square inches: $2\frac{2}{3}$ feet stroke . = 5280 " "

Adding, we have . . 9280 " "

Deducting friction and atmospheric pressure = 3450 " "

And there remains a clear effect of . 5830 " "

or $48{\cdot}58\frac{1}{3}$ per cent. with one-third the amount of steam, and 17,490 lbs. lifted one foot, or $145\frac{3}{4}$ per cent. with full steam.

4th. The mechanical effect of cutting off at one-quarter stroke will be 60 lbs. per square inch, or 3000 lbs. per 50 square inches: 1 foot stroke = 3000 lbs. lifted one foot.

36·595 lbs. mean pressure per square inch, or $1829\frac{3}{4}$ lbs. per 50 square inches: 3 feet stroke . = $5489\frac{1}{4}$ " "

Adding, we have . . $8489\frac{1}{4}$ " "

Deducting friction and atmospheric pressure = 3450 " "

And there remains a clear effect of . $5039\frac{1}{4}$ " "

or nearly 42 per cent. with one-quarter the amount of steam, and 20,157 lbs. lifted one foot, or 168 per cent. with full steam.

* It only remains to investigate, if under a different pressure the relations will be the same: we will, therefore, take the same cylinders and strokes, with a pressure of 36 lbs.

1st. The mechanical effect of full stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 6 feet stroke . = 43,200 lbs. lifted one foot.

Deducting for friction $2\frac{1}{2}$ lbs. per square inch = 500 lbs., or 3000 lbs. lifted one foot, and atmospheric pressure $14\frac{3}{4}$ lbs. per square inch = 2950 lbs., or 17,700 lbs. lifted one foot = 20,700 " "

Leaving a clear effect of . 22,500 " "

or 52·083 per cent.

2d. The mechanical effect of cutting off at one-half stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 3 feet stroke = 21,600 lbs. lifted one foot.

26·513 lbs. mean pressure per square inch, or 5302·6 per 200 square inches: 3 feet stroke . = 15,907·8 " "

Adding, we have . . 37,507·8 " "

Deducting friction and atmospheric pressure = 20,700·0 " "

Leaving a clear effect of . 16,807·8 " "

or 38·905 per cent. with one-half the amount of steam, and 33,615·6 lbs. lifted one foot, or 77·810 per cent. with full steam.

3d. The mechanical effect of cutting off at one-third stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 2 feet stroke = 14,400 lbs. lifted one foot.

23·48 lbs. mean pressure per square inch, or 4696 lbs. per 200 square inches: 4 feet stroke . = 18,784 " "

Adding, we have . .	33,184	"	"
Deducting friction and atmospheric pressure =	20,700	"	"
Leaving a clear effect of .	12,484	"	"

or 28·9 per cent. with one-third the amount of steam, and 37,452 lbs. lifted one foot, or 86·7 per cent. with full steam.

4th. The mechanical effect of cutting off at one-quarter stroke will be 36 lbs. per square inch, or 7200 lbs. per 200 square inches: 1½ feet stroke . . . = 10,800 lbs. lifted one foot.

22·0178 lbs. mean pressure per square inch, or 4403·56 lbs. per 200 square inches: 4½ feet stroke . = 19,816 " "

Adding, we have . .	30,616	"	"
Deducting friction and atmospheric pressure . =	20,700	"	"
Leaving a clear effect of . .	9,916	"	"

or 22·95 per cent. with one-quarter the amount of steam, and 39,664 lbs. lifted one foot, or 91·81 per cent. with full steam.

The same per centage exists under the same pressure, whatever the diameter of the cylinder or length of the stroke may be.

In the foregoing calculations, condensation in the cylinder has not been taken into consideration; it will, of course, be greater in proportion to the cut-off being smaller, but the difference to me seems to be trifling, and will cause but little alteration in the above calculations of per centage.

And now, having arrived at a point from which we are enabled to deduce certain elements, the subjoined are submitted:—

1st. The pressure of steam in the cylinder at the end of the stroke, when cut off at any point during the stroke, is smaller than the proportion to the full pressure; and this difference becomes greater, first, with the increase of pressure, and secondly, with the decrease of cutting off.

2d. The per centage of mechanical effect between that of full stroke and that of cutting off at any point of the stroke, remains the same, the cylinder being large or small, the stroke long or short, as long as the pressure is the same.

3d. The greater the pressure the greater the per centage of mechanical effect in high pressure engines, under all circumstances. (The relations seem to be different in low pressure engines, which I propose to discuss at a future time.)

4th. The greater the pressure, the greater the relative per centage between the full stroke and the cut-off system.

5th. There is no such thing as a greater mechanical effect in the same cylinder and at the same pressure, when cut-offs are used instead of full steam during the whole stroke; but, on the contrary, there is a proportionate and not inconsiderable falling off of mechanical effect when the former is used, notwithstanding all that has been or may be said to the contrary, and this difference becomes greater with a lesser pressure.

6th. The same amount of steam, under the same pressure, in the same cylinder, used with cut-offs instead of following full stroke, will produce a greater mechanical effect, but it requires a greater space of time; it being in the same proportion as the relative per centage between full stroke and cut-offs, or *vice versa.* During the same space of time, when cut-offs are used, and using a proportionate increase of pressure representing a greater volume of steam, the same mechanical effect will be obtained as that in following full stroke with a lesser amount of steam; or during the same space of time, and with the same amount of steam at a proportionate higher pressure, a greater mechanical effect will be obtained in using cut-offs as in following full stroke.

And now, allow me to remark, that here we have a full explanation of what has been asserted, that the mechanical effect in changing the full stroke to any part of the cut-off, during the working of the engine, was found to be greater in the latter case than in the former.

Suppose we have the same engine as that from which we drew our first deductions, *i. e.*, 200 square inches area, 6 feet stroke, and 60 lbs. pressure. Then we will have, as shown, a clear mechanical effect of 51,300 lbs., or 71¼ per cent. of the power exerted by the steam. I have further shown, that when the feeding of steam is cut-off at one-half stroke, we have a clear mechanical effect of 41,709 lbs., or 57·93 per cent., or with the same amount of steam used at full stroke, 83,418 lbs. effect, or 115·86 per cent. The fire or the production of heat not being changed in using the cut-off, it is evident that with each stroke of the engine, 4⅙ cubic feet of steam will be used less than before, the production remaining the same: and now let us take the steam space at 100 cubic feet, and the engine running only 12 revolutions per minute, and we have the startling result that, in less than one minute, the pressure in the boiler will be found to be at 100 lbs. per square inch, provided the safety valve be loaded to that amount; and its clear effect will be 83,300 lbs. lifted one foot, or 115·69 per cent., instead of 71¼ per cent. when full stroke was used. But when the safety valve remains loaded with 60 lbs. in working order, and its orifice is proportionate to the production of all the steam, then, gentlemen, there is no such thing as the engine beginning to jump, or attempting to "run away;" but, on the contrary, its speed will fall off almost immediately, until not more than 57·93 per cent. of the former 71¼ per cent. will remain.

7th. From the above deductions, drawn from calculations, we now arrive at the conclusion that a much greater mechanical effect is attained in using cut-offs instead of following full stroke, when the same volume of steam is used, or the same effect is attained with a lesser volume of steam: the consequence is, that the production of a lesser volume of steam, requiring a lesser quantity of heat, the same mechanical effect, in using cut-offs instead of following full stroke, is attained with a lesser amount of coal, all conditions being otherwise equal. Therefore, let me add, go ahead, busy inventors, and give us an improved cut-off, that will answer our purposes well, and give satisfaction to all.

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Strength of Materials: Deduced from the latest experiments of Barlow, Buchanan, Fairbairn, Hodgkinson, Stephenson, Major Wade, U. S. Ordnance Corps, and others. By Chas. H. Haswell, Civil and Marine Engineer.

No. 2.

(Continued from page 343.)

Transverse Strength.

The Transverse or Lateral Strength of any Beam, Rod, Bar, &c., &c., &c., is in proportion to the product of its breadth, and the square of its depth; and in like sided beams, bars, &c., it is as the cube of the side, and in cylinders as the diameter of the section.

When one end is Fixed and the other projecting, the strength is inversely as the distance of the weight from the section acted upon; and the strain upon any section is directly as the distance of the weight from that section.

When both ends are Supported, only, the strength is four times greater for an equal length, when the weight is applied in the middle between the supports, than if one end only is fixed.

When both ends are Fixed, the strength is six times greater for an equal length, when the weight is applied in the middle, than if one end only is fixed.

The strength of any rod, bar, &c., &c., to support a weight in the centre of it, *when the ends rest merely upon two supports*, compared to one *when the ends are fixed*, is as 2 to 3.

When the Weight or Strain is uniformly distributed, the weight or strain that can be supported, compared with that when the weight or strain is applied at one end or in the middle between the supports, is as 2 to 1.

In Metals, the greater the dimension of the side of a beam, &c., or the diameter of a cylinder, the less its proportionate transverse strength.

The strength of a *Cylinder*, compared to a *Square* of like diameter and sides, is as 4·71 to 8.

The strength of a *Hollow cylinder* is to that of a *Solid cylinder*, of the same length and quantity of matter, as the greater diameter of the former is to the diameter of the latter; and the strength of *hollow cylinders*, of the same length, weight, and material, is as their greatest diameters.

The strength of an *Equilateral Triangle*, having an edge up, compared to a *Square* of the same area, is as 22 to 27; and the strength of an equilateral triangle, having an *edge down*, compared to one, an *edge up*, is as 38 to 23.

NOTE.—In these comparisons the beam or bar is considered as one end being fixed, the weight suspended from the other. In Barlow, and other authors, the comparison is made when the bar or beam rested upon supports. Hence, the stress is contrariwise.

Detrusion is the resistance that the particles or fibres of materials oppose to their sliding on each other, under a detrusive strain. Punching and shearing are detrusive strains.

Deflection.—When a beam, bar, &c., &c., is deflected by a cross strain, the side of the bar, &c., which is bounded by the concave surface is *compressed* and the opposite side is *extended.*

The *Neutral Line*, or *Axis of Equilibrium*, is the line at which extension terminates and compression begins.

In Stones and Cast metals, the resistance to compression is greater than the resistance to extension.

In Woods, the resistance to extension is greater than the resistance to compression.

The general law regarding deflection is, that it increases, *cæteris paribus*, directly as the cube of the length of the rod, bar, &c., and inversely, as the breadth and cube of the depth.

The *Resilience* or toughness of a body, is a combination of flexibility and strength.

The resistance of *Flexure* of a body at its cross section is very nearly nine-tenths of its tensile resistance.

Relative Stiffness of materials to resist a transverse strain:—

Wrought Iron,	1·3	Oak,	·095
Cast Iron,	1·	Ash,	·089
White Pine,	1·	Beech,	·073
Yellow Pine,	·087	Elm,	·073

The strength of a Rectangular Beam in an *Inclined position* to resist a vertical stress, is to its strength in a horizontal position, as the square of radius, to the square of the cosine of elevation; that is:—as the square of the length of the beam, to the square of the distance between its points of support, measured upon a horizontal plane.

Beams of cast metal, having small dimensions, are stronger *pro rata* than those having larger dimensions, in consequence of their having a greater proportion of chilled surface compared to their elements of strength resulting from dimensions alone.

Experiments upon bars of cast iron, 1, 2, and 3 inches square, give a result of 447, 348, and 338 lbs., respectively; being in the ratio of 1·, ·78, and ·756.

The strongest rectangular beam that can be cut of a cylinder, is one of which the squares of the breadth and depth of it, and the diameter of the cylinder, are as 1, 2, and 3, respectively.

TABLE OF THE TRANSVERSE STRENGTH OF MATERIALS: Deduced from the experiments of U. S. Ordnance Department, Barlow, Rennie, Stephenson, Hodgkinson, Fairbairn, Pasley, Hatfield, and the Author, and reduced to a uniform measure of *One Inch Square, and One Foot in Length; Weight Suspended from one end.*

MATERIALS.	Specific gravity.	Breaking weight.	Weight borne while the elasticity was perfect.	Value of W for general use.
WOODS.				
Teak,	·745	206 lbs.	65·5 lbs.	60
Oak, English	·934	140	43·8	35
do superior	·748	183		45
Canadian	·872	146	49·5	36
American do		230		50
Dantzic	·756	122	43·8	30
African	·982	203		50
Ash,	·760	168	49·5	55
Beech,	·696	130	33·	32
Birch,	·711	160		40
Elm,	·553	82	27·5	25
		170	45·	40
Pitch Pine,	·660	136	33·	45
American	·777	160		50
White Pine,	·553	92	33·	30
American		130		45
Riga Fir,	·753	94	27·5	30
Norway Pine,	·577	123	44·	40
Locust,	·936	295		100
Deal, Christiana	·698	137		45
Larch,	·556	98	33·	25
White wood,		116		38
Maple,		202		65
Hickory		250		55
Chestnut		160		53
Riga Fir, Wet	·632	107		30
Dry	·380	96		30
METALS.				
Cast Iron, American, means of five divisions of grades.	7·087	507		125 to 160
	7·182	632		155 210
	7·246	733		180 240
	7·270	762		190 250
	7·340	772		192 250
Mean by Maj. Wade	7·225	681		170 225
West Pt. Found. extreme		980		250 325
English,—Low Moor Cold blast	7·055	472		110 140
Gartsherrie, Hot "	7·017	447		
Carron, Cold "	7·094	443		
Muirkirk, Hot "	6·953	418		
Ponkey, Cold "	7·122	581		145 190
Hot blast, mean		500		125 165
Cold " "		516		130 170
Ystalyfera, cold blast		770		195 255
Mean of 65 kinds,		500		125 165

Materials.	Specific gravity.	Breaking weight.	Weight borne while the elasticity was perfect.	Value of W for general use.
Metals (Continued).				
Steel, greatest . .	7·862	1918		400 to 500
		Permanent bend.		
Wrought Iron				
American .	1500	700 / 650 / 600		160 210
English .	1000	400		100 130
"	1080	520		130 170
" .	1200	550		135 180
Swedish* .		665·		165 220
English, the stress applied horizontally,		set. ·001 in. 190		180 240
Mixture of Cast and Wrought Iron, &c.				
Cast Iron, Blaenarvon .	575			145
do 10 pr. ct. of wrought	703			175
20 "	842			210
30 "	920			230
40 "	767			195
50 "	727			185
and 2½ per cent. of Nickel,	693			173
mean	750			188
Stirling, 2d quality	623			154
3d "	499			125
Stones (American).				
Flagging, Blue .	2·707	31·		
Freestone, Little Falls, N. Y.,	2·326	24·		
Belleville, N. J.,	2·300	20·1 / 17·8		
Connecticut .	2·462	13·		
Dorchester .	2·289	10·8		
Aubigny, .	2·472	9·3		
Caen .	2·218	6·1		
Granite, blue, coarse .	2·604	18·		
Quincy, Mass., .	2·658	26·		
Stones (English).				
Yorkshire Blue Stone, .		26·		
Paving, .		10·4		
Landing, .		22·5		
Caithness Paving, Scotland .		68·		
Valentia do., Ireland		68·5		
Welsh do., .		157·		
Arbroath, . .		17·		
Craigleith Sandstone, .	2·266	10·7		
Hailes, . .		7·4		
Felling, . .		7·5		
Kentish Rag, . .		35·8		
Cornish Granite, .		22·		
Portland Oolite, . .	2·145	21·2		
Bath, . .		5·2		
Bangor Slate, . .		90·		
Llangollen do., .		43·		

* With 840 lbs. the deflection was 1 inch, and the elasticity of the metal destroyed.

CONCRETES (English).	Breaking weight.
Aberthaw lime 1, gravel 7,	·8
Hydraulic lime and gravel (old),	2·
Fire brick beam, Portland cement,	3·1
do, sand 3 parts, lime 1 part,	·7
CEMENTS (English).	
Portland,	37·5 30·4 10·2
do 1 part, sand 2 parts,	10·
Blue clay 5 parts, chalk 4 parts,	14·3 5·8
Blue clay and chalk,	5·4
Sheppy,	5·
BRICKS (English).	
Fire brick,	14·
Stock brick, well burned,	5·8
do inferior burned,	2·5
Old brick, English,	9·1
New " English,	10·7
Best stock, English,	11·8

COMPARATIVE TRANSVERSE STRENGTH OF A PRISM OF LIME AND CEMENT MIXED WITH VARIOUS PREPARATIONS OF GRAVEL AND SAND (Sir C. W. PASLEY).

One Inch Square, and One Foot in Length, the Weight being Suspended from one end.

MIXTURE.	Days immersed in water.	Age in days.	Breaking weight.
Chalk lime 1, Sand 3·25,	19	396	·81 lbs.
do 1, Gravel 3, Sand 4,		446	·156
do 1, Gravel 6, Sand 3,	32	446	·39
Halling lime 1, Sand 3,		342	1·40
do 1, Gravel 4, Sand 2,	18	457	1·62
do 1, Gravel 6, Sand, 3,	32	453	1·43
Blue Lias lime 1, Gravel 6, Sand 3,		345	·80
Rosehill lime 1, Sand 2,		342	1·56
Sheppy and Harwich Cements 1, and Gravel 1·5, Sand 2·0,		385	·93
Chalk 5, Blue clay 2, Gravel 1·5, Sand 2·0,		385	·156
Chalk 5, Blue clay 2, Gravel 5, Sand 2,		439	·41
Chalk 5, Blue clay 1, Gravel 3, Sand 4,	18	431	·76
Chalk 5, Blue clay 1, Gravel 6, Sand 2,	18	431	1·03
Chalk 6, Blue clay 1, Gravel 5, Sand 4,	16	429	·45
Chalk 7, Blue clay 1, Gravel 5, Sand 4,	16	429	·44
Chalk lime 1, Screened ballast 5,		270	1·12
do 1, do 10,		256	·27
Halling lime 1, do 3,		270	1·40
do 1, do 10,		270	·42
Blue Lias lime 1, Ballast, 6,		239	1·08
do 1, do 10,		268	·33
Sheppy & Harwich Cements 1, do 2,		143	1·04
do 1, do 7,		234	·12

Table of the Transverse Strength of Cast Iron Bars and Oak Beams of Various Figures,

Having a Uniform Sectional Area of One Square Inch, One Foot in Length, Fixed at one end, Weight Suspended from the other.

	Form of Bar or Beam.		Breaking weight.
Cast Iron.	■	Square,	673 lbs.
	◆	do, diagonal vertical,	568
	●	Cylinder,	573
	◉	Hollow Cylinder, greater diameter twice that of less,	794
	▮	Rectangular, 2 ins deep × $\frac{1}{2}$ in. thick,	1456
		do 3 " × $\frac{1}{3}$ "	2392
		do 4 " × $\frac{1}{4}$ "	2652
	▲	Equilateral triangle, an edge up,	560
	▼	do, an edge down,	958
	⊤	2 ins. deep × 2 ins. wide × ·268 ins. thick,	2068
	⊥	" " "	555
Oak,	▲	Equilateral triangle, an edge up,	114
	▼	do, an edge down,	130

Table of the Transverse Strength of Solid and Hollow Cylinders of Various Materials,

One Foot in Length, Weight Suspended from one end.

Materials.	Specific gravity.	Solid external diameter in inches.	Hollow internal diameter in inches.	Breaking weight in lbs.	Breaking weight for 1 inch external diameter, and proportionate internal diameter.
Woods (English).					
Fir,* . .	·588	2·		772	97
Ash, .	·590	2·		685	86
" . .	·580	2·	1·	604	75
" .	·601	2·	·75	625	78
" . .	·586	2·	·50	636	79
White Pine, American		1·		75	75
"		2·		610	76
Metals.					
Cast iron, cold blast		3·		12,000	444
Stone Ware.					
Rolled pipe of fine clay.		2·87	1·928	190	8

* An inch square batten from the same plank as this specimen, broke at 130 lbs.

RESULT OF EXPERIMENTS ON THE TRANSVERSE STRENGTH OF SCARPHED BATTENS (BARLOW.)

Battens 4 feet in length, Fixed at One end, and Loaded at the other.

[*Note.*—Dimensions of battens not given.]

Scarph, 12 inches in length, small end up, and one inch from face of fulcrum, .	Broke in the neck of the scarph, close to the fulcrum,	87 lbs.
Scarph, 12 inches in length, large end up, and one inch from face of fulcrum, .	Fastenings of small end of scarph drew out, .	101
Scarph, vertical, .	Broke in the scarph, .	211

(To be Continued.)

*The Cylindrical Spiral Boiler.** By JOHN ELDER.

The object of the construction of this boiler is to obtain a form with all the useful properties of the simple cylindrical high-pressure boiler on shore, adapted to steamships. The following advantages appear to be attained over the ordinary marine boiler, namely:

1. A form of boiler capable of carrying higher pressure and presenting more heating surface, and of a more effective description, from a given weight of material.

2. A boiler capable of being easier cleaned and repaired in both water and fire spaces.

3. A boiler capable of producing superheated steam to any practical temperature.

4. A less average specific gravity of water whilst working at sea with the usual amount of feed and blow-off, and a more perfect combustion-chamber, and better formation of flue surface.

5. The pressure being altogether internal, it is not liable to collapse, a danger lately ably demonstrated by Mr. Fairbairn; and as the diameter of the various cylinders are reduced to the minimum size for permitting the tradesmen to pass through, clean and repair them, the boiler when formed of ordinary thickness possesses enormous strength without stays.

6. The expense of the boiler per square foot of heating surface is about the same as the ordinary boiler, and is capable of carrying five times the pressure.

The general construction of this boiler is as follows:—There are twenty-four round boilers or tubes, of not less than 19 inches diameter each, twenty-two of these forming, when bound together, a cylindrical vertical shell; the twenty-third, a centre boiler concentric to that shell; and the twenty-fourth, a spiral coil-boiler winding spirally round

* From the London Civ. Eng. and Arch. Jour., September, 1860.

between the centre boiler and those composing the circumference shell. These boilers contain the water, and the spaces between them the fire.

The feed-water passes first into the spiral compartment, or No. 24, and from it into the centre compartment, or No. 23, and into each in rotation, and blows off at the last compartment, or No. 1, thus rendering the water in No. 24 nearly pure sea-water, and gradually from compartment to compartment more dense, till it blows off at No 1 at the usual density, and thus makes the average specific gravity of the water less than usual.

The twenty-two outside boilers are 24 feet long, 19 inches diameter, and $\frac{5}{16}$-inch thick; the bottom ends are conical for 3 feet, and knee'd outwardly to give a larger diameter of furnace, say 12 feet diameter. There is a furnace door for every alternate tube, or say 11 furnace doors, equally divided round the base of the boiler, giving great facility to the firemen for doing their work efficiently. In firing it is proposed to charge all the fresh coal round the circumference of the fire, in order that the hydrogen of the coal may be consumed separately from the carbon; and as the furnace has great altitude, the combustion will be completed in vertical flames from the coals, and will thus prevent the carbonic acid gas given out from the combustion of the carbon coming so much in contact with and preventing the combustion of the hydrogen, as is usual in ordinary furnaces.

The centre compartment, or No. 23, is 30 feet long, 34 inches diameter, and $\frac{3}{8}$-inch thick, with 3 feet at the bottom and top conically reduced to 18 inches diameter, forming a man-hole door; the upper end of this vertical tube forms a reservoir for the steam of the whole twenty-four compartments, and acts as a superheating apparatus, and may be carried up the funnel to the extent necessary to superheat the steam to 400°. The steam-pipe is taken from the top of this boiler to the safety-valve chest, fastened on the front of the boiler low down, which serves as a water-trap during the discharge from the safety-valve chest, the steam-pipe to the engines being taken off the same pipe at a higher level than the escape steam. The spiral compartment, or No. 24, is about 100 feet long, 34 inches diameter, and $\frac{3}{8}$-inch thick, made of the best iron boiler-plate; the ends are conical for 3 feet formed into man-hole doors; this spiral boiler makes four or five convolutions close round the centre one, and is bound close to the circumferential boilers by hollow stay-bolts, and fastened to the centre one at each end only; in the same manner the steam and water flows through the whole boiler by these hollow bolts or rivets, and completes the entire circulation of water and steam. The whole of these 24 compartments or boilers terminate at the bottom about 1 foot below the fire-grate, and are supported on six stanchions from the ash-pit beneath, making a free passage for the air under the grate bar; the circumferential compartments or boilers terminate at the top 6 feet above the ship's deck, and have each a man-hole door forming the cover; the funnel is made conical at the bottom to embrace the internal diameter of the boiler shell and draw off the smoke in the usual manner. This completes the whole boiler proper, but in order to prevent radiation of heat,

a thin outer casing of iron is made (9 inches) clear of the boiler all round, terminating about 7 feet from the stoke-hole floor; and above, at the level of the galley or funnel-house, this casing is lined with felt and thin wood, to keep the deck and the adjacent parts cool and retain the heat. The twenty-two straight cylindrical boilers or compartments are constructed in the sides by four plates 24 feet long and 16 inches broad, rolled to a 9½-inch radius curve at the iron works, leaving no plate-setting for the boiler-maker of this description.

The plates of boiler No. 24, or the spiral compartment, are delivered flat by the iron-maker, and are bent to the spiral curve by one blow of a large spiral concave block falling upon a counterpart convex one, prepared by the constructors of the boiler. This operation has been found to simplify the making of this spiral cylindrical boiler to about the same amount as the straight cylindrical boilers. The conical ends are bent in the same manner as the spiral plates, and the whole work of plate-bending reduced as far as possible to machine work. The products of combustion, after leaving the furnace, have to travel spirally upwards a distance of 100 feet, and must of necessity be continually rotating during that time, and prevent the possibility of any portion passing off without being brought frequently in contact with the heating surface of the boiler, and will therefore be cooled down to the minimum temperature compatible with a given amount of cooling surface, or the greatest quantity of heat extracted from the products of combustion before their escape to the atmosphere.

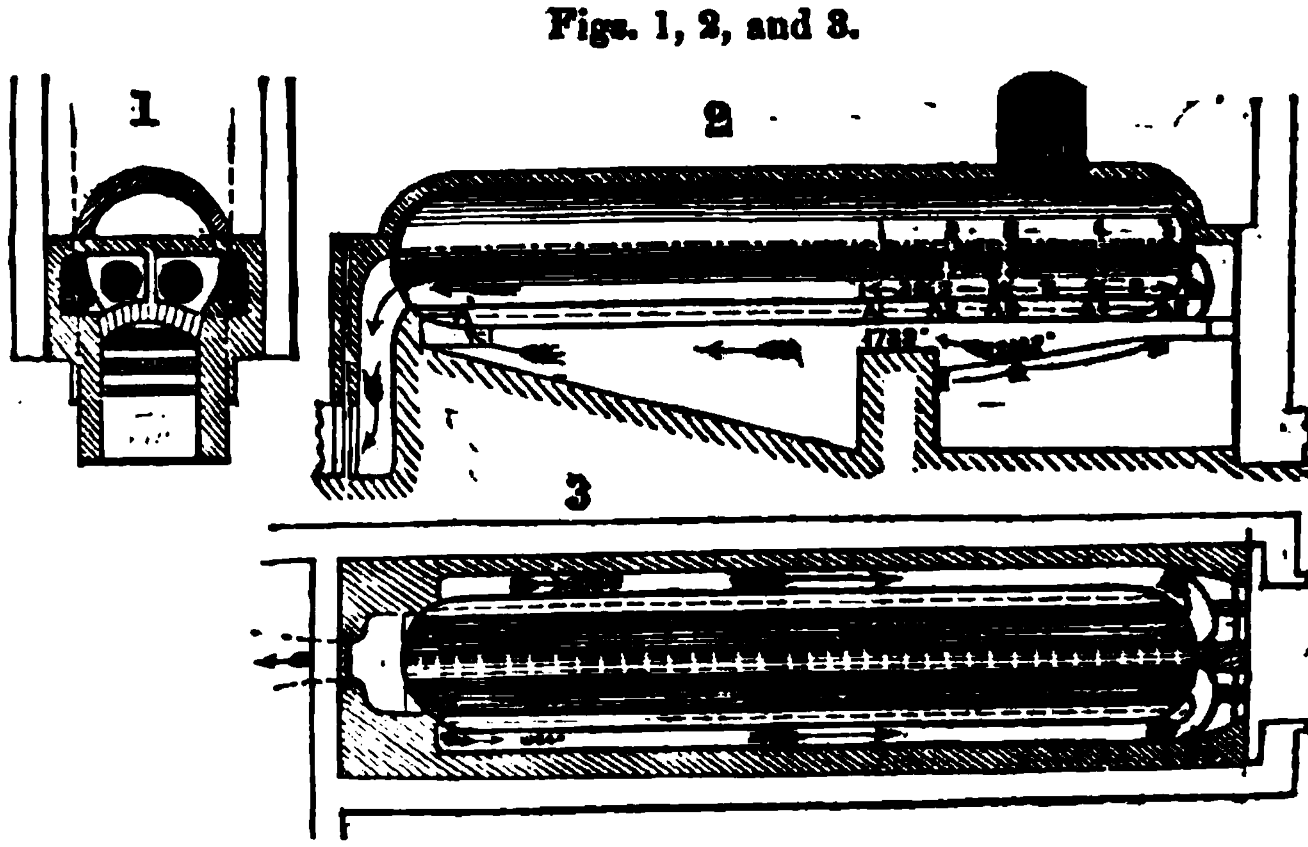
This spiral coil and all the heating surfaces will keep more clear of flue-dust than usual, and will consequently be more efficient in that respect, as well as save the usual trouble and loss by spunging experienced in the ordinary tubular boilers at sea. Also, as the products of combustion must pass off at the rate of at least 7 feet per second, in this as in ordinary boilers, it will take upwards of 14 seconds from the time it leaves the furnace till it arrives at the top of the boiler; whilst if the boiler were of the ordinary tubular type it would pass in about two seconds along the whole heating surface of the boiler; the gas has, therefore, seven times more time to give out its heat, and its revolving tendency will not admit of the same stratum of gas passing along the passages after it is cooled down, as is the case with the ordinary boiler, but will bring the hot products of combustion usually occupying the centre of the tubes of a tubular boiler into contact with the cooling surfaces, and reduce the whole products of combustion to one temperature before entering the chimney.

In cleaning the salt or sludge out of these boilers the man and sludge hole doors are taken off the top and bottom (and the hose of fresh water may be played down through from the top, and the refuse run out at the bottom). The man in charge can also pass down through the whole boiler; the dimensions necessary for this purpose being made the minimum and maximum of the various compartments of the boiler; and are specially constructed to maintain to the engines steam at a much higher pressure than usual, in order to admit of a much larger amount of expansion to be developed by the engines, which are all on

the double cylinder expansive principle. The constructors are now making the boilers for three steamships on this principle, two of which are for carrying Her Majesty's mails on the Pacific between Valparaiso and Panama (as described by the writer at the meeting of the British Association at Leeds); and it has long been his desire to be able to construct boilers for marine purposes without stays, and with no surface exposed to the collapsing tendency, which in so many cases has been the cause of loss of life aboard of steam-ships. The boilers now described have no large flat surfaces and no stays, the whole tendency of the pressures being to inflate the boiler plates, and, if possible, to give them a stronger form; the smallest diameter is large enough to give access to the men in charge, and the largest diameter is 34 inches, and ⅜-inch thick,—dimensions that can carry several hundred pounds pressure on the square inch before rupture could take place. Such a form the writer adopts with great satisfaction to himself as a constructor sending machinery abroad, where the usual form of boiler gives him considerable anxiety. In comparing the construction of this boiler with that of the ordinary tubular one, in the latter angle-iron ribs and stays now compose a large portion of the weight and expense; contribute no heating surfaces; and if one stay breaks, which is no uncommon occurrence, the next is placed in great danger, and if it gives way the whole may follow in rotation and a serious accident be the result. In the former boiler, however, the plates may be reduced to a very small amount of thickness by tear and wear before explosion could be expected.

Having thus described the objects of the spiral boiler, it might not be out of place to give the following statement of the comparative evaporative power and temperature of the gases in the furnace and chimney of the spiral boiler, with three of the ordinary types of boiler now in general use.

Figs. 1, 2, and 3.



The three types experimented upon, were, first, a common cylindrical land boiler (Figs. 1, 2, and 3), 33 feet long, 5 feet 6 inches diameter, with two round flues 19 inches diameter through the centre; this boiler had 40 feet of heating surface to the nominal horse-power

of the engine; the two flues contained 20 feet, and the shell 20 feet per nominal horse-power; the furnace was below the boiler at the fore end, had a fire-grate of 26 square feet, the fire passed underneath the boiler to the opposite end from the furnace, and returned along the sides, and then passed back again through the flues to the chimney. The temperature above the centre of the fire was found to be, on one occasion, 3200°; at the top of the bridge 1730°; the temperature of the gases gradually reduced as they passed back the remaining length of 26 feet under the boiler and along the side flues, till they entered the flues at 1163°, and left them at 800°. Thus the furnace containing a surface of 2 feet per nominal horse-power reduced the heat about 1500°, the shell of the boiler behind the furnace of about 18 feet per nominal horse-power reduced the temperature about 600°, and the flues containing a surface of 20 feet per nominal horse-power reduced the temperature about 350°. The temperatures of the gases in the flues were found to be about the same in the centre as at the top; but at the bottom of the flues, the temperatures of the gases were at the fore-end rather less than at the top, but towards the back-end the temperature of the bottom of the flues reduced gradually below the temperature at the top to the extent of 300°. Upon another occasion the temperature over the centre of the fire was found to be 3610°; at the top of the bridge 1739°; and the different temperatures of the flues were as indicated in Fig. 2, where the average temperatures of the flues at $B^1=826°$, $B^2=879°$, $B^3=937°$, $B^4=959°$, and at $B^5=981$. The temperatures at the top of the flues at $C^3=982°$, $C^4=1034°$, $C^5=1087°$. The temperatures at the bottom of the flues at $A^1=571°$, $A^2=603°$, $A^3=678°$, $A^4=764°$, $A^5=822°$. It would therefore appear that, notwithstanding the large amount of surface in this boiler, the evaporative power is very inferior, as the amount of heat taken out of the gases per square foot of heating surface is very small; and the natural conclusion is that the gases pass along in straight lines, and only the thin strata in contact with the surface is cooled down. In the results of the spiral boiler (Fig. 6) three times the quantity of heating surface was found to reduce six times the quantity of gas from the same temperature of 3200° to a temperature of 480° instead of 800°, showing that a more complete turning over of the gases is much wanted in our land boilers. The water evaporated per hour in the land boiler referred to was found by meter to be 2000 lbs., and the coal, best Glasgow quality, found to be 300 lbs. per hour; making about 6½ lbs. of water per pound of coal. During the measurement of the water evaporated by the meter, indicator diagrams of the engine were taken with a view to calculate the weights of steam by the ordinary method, and the calculations were found to agree with the meter; these calculations can be repeated and substantiated at any time.

The second type of boiler tested was that of the ordinary steam-boat horizontal tubular boiler (Fig. 4); the example chosen was one in a first-class ocean steamer. The temperature of the furnace was found to be 3200°, and the inside of the funnel about 1100°. The heating surface of this boiler was 22 feet per nominal horse-power, and

the water evaporated about 8½ lbs. per pound of coal according to the calculations from the diagrams. The coal consumed was about 20 lbs. per square foot of fire-grate, of the best Glasgow coal.

The next example taken was that of a first-class vertical tubular boiler (Fig. 5), on Mr. David Napier's principle, now universally liked on the Clyde for river steamers. This boiler had a surface of about

Fig 4.

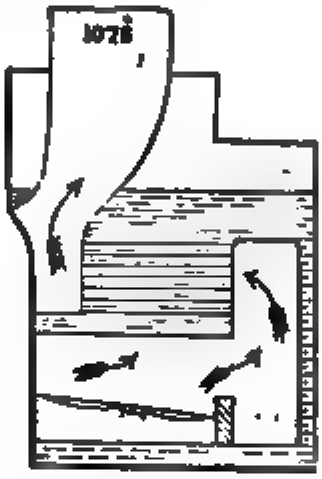


Fig. 5.

22 feet per nominal horse-power; the temperature of the fire was found to be about 3300°, and in the funnel 1160°; the weight of water evaporated was found by calculation to be 8¾ lbs. per pound of coal consumed, and the rate of combustion about 20 lbs. per square foot of fire-grate.

In the spiral boiler (Fig. 6) of the *San Carlos*, *Guayaquil*, and *Prinz van Orange*, the boilers were found to give the following peculiar results:—1st, that even with Scotch coal there was no smoke emitted from the chimney, and no carelessness on the part of the fireman seemed to effect the formation of smoke; 2d, that the boilers showed a bright furnace, indicating first-class draft; the temperature of the funnel was found to be 480° while the fire was at its greatest energy. The heating surface was, in the case of the *San Carlos* and *Guayaquil*, 2200 square feet, the coal consumed 1400 lbs. per hour, and the water evaporated 11 lbs. per pound of coal consumed; the fire-grate contained about 76 square feet, and the rate of combustion about 20 lbs. per square foot of fire-grate. The heating surface of the boiler was 18 feet per nominal horse-power; the coal consumed was Glasgow best steam coal. The stoke-hole was found to be remarkably cool, and the boiler, which was loaded to 52 lbs. on the square inch steam pressure, and tested to 150 lbs. on the square inch water pressure, was found to be perfectly tight. In the case of the *San Carlos*, I may mention that the ship has now steamed about 20,000 miles, and has not been in any port more than three days; during that time she has been consuming soft Chili coal for a

Fig. 6.

considerable part of her voyage, and the merits of the long flue show a decided advantage in this boiler over the ordinary tubular boiler for the native bituminous coal of South America.

In order to give in a more extended form the comparative evaporative power of various flue and tubular boilers, the writer begs to lay before the Association the accompanying table. It shows several proportions of heating surface and evaporative power of several ships that have come under his notice. He can certify the accuracy of most of these particulars, except that shown in the last column, which is taken from Professor Rankine's report on the performance of the *Thetis.* This vessel has about six times more heating surface in her boilers in proportion to the coal consumed than any example the writer is aware of. The boiler is Craddock's patent boiler, though that inventor's name appears rarely to be mentioned in connexion with the said vessel. Efficient, however, as this boiler must be as an evaporator, it cannot possibly accomplish the quantity shown in the table.

Comparisons of certain Results obtained from Certified Diagrams of Steamers.

	Elk.	Earl of Ab'rd'n.	Valparaiso.	Pride of Erin.	Inka.	Europa.	Camb'n.	Thetis:
Nominal horse-power,	250	380	320	400	80	648	472	80
Indicated "	780	780	826	960	272	1207	1072	226
Propor'n of indicated H.P. to nominal ditto,	3·23	2·05	2·581	2.4	3·8	1·863	2·272	2·82
Diameter of cylinder,	57 in.	70 in.	Two 52 Two 90	72	Two 28 Two 48	90	77·5	One 21 One 42
Length of stroke,	5 ft. 6 in.	6 ft.	5 ft.	5 ft. 6 in.	3 ft.	8 ft.	7 ft. 6 in.	2 ft. 6 in.
No. strokes per minute,	25	17·5	24	22	32	15¼	16	52
Boilers—flue or tubular,	Tubular.	Flue.	Flue.	Flue.	Flue.	Flue.	Flue.	Craddock's Patent.
Area of fire-grate,	144 ft.	190	130	252	50	314	247	
Area of heating surface,	4000	4300	2400	4400	480	7000	5400	Ab't 4000
Coals consumed per h.,	3360 lb.	3584	2520	4928	672	5100	4480	226
Quality of coal,	Glasgow best.	New-castle.	Welsh.	Welsh.	Welsh.	Welsh.	Welsh.	Good.
St. ev'ted per lb. of coal,	7·354	6·87	7·74	7·159	8·1	7·7	7·509	Ab't 15 lb.
Estimate, water ev'ted,	8·1	7·4	8·6	7·9	9·0	8·5	8·3	18 lb.
Coal consumed per I.H.P.,	4·071	4·385	3·05	5·126	2·47	4·2	4·17	1·018
Fire-grate per nom. H.P.,	·576	·5	·406	·63	·625	·484	·536	

The theoretical quantity of water capable of being heated from 90°, and evaporated at, say 212°, with an infinite quantity of heating surface and a perfect fire, is somewhere about 13½ lbs. per pound of coal; whilst from the diagrams represented in Prof. Rankine's report of the *Thetis'* performance, 18 lbs. weight appears to be about the quantity of water per pound of coal. This calculation I have made from the diagrams published, and any party interested may repeat the calculations.

The calculation is made as follows:—The area of the large cylinder as shown in the diagram is 1380 square inches, or 9·583 square feet. The four revolutions of piston marked on the diagram, 49½, 52, 53, and 52 revolutions per minute, with a stroke of 2½ feet, or say 258·12 feet per minute, gives $258{\cdot}12 \times 9{\cdot}583 \times 60 = 146433$ cubic feet per hour. And if we take the average pressure shown in the four diagrams at the end of the piston stroke, supposing the barometer to be 14·5 lbs., we find the weight of that steam to be about 44 cubic feet per lb.; this number, therefore, divided by 44, gives the quantity of steam as 3300 lbs.

per hour; to this must be added one-twentieth for contents of ports and clearance, which makes 3465 lbs. of steam.

This clearly gives the weight of the steam per hour given out of the cylinders after the work is performed; to this, therefore, must be added the quantity of heat that must have disappeared during the performance of the work; this in the case of the *Thetis* is about $\frac{1}{5}$ of the entire heat; we must, therefore, add $\frac{1}{5}$, or, say, $3465+693=4158$ lbs. of water must have been raised from a temperature of about 100° and evaporated, or say 18 lbs. of water to the pound of coal said to be consumed. This result is about equal to 20 lbs. of water evaporated at 212° to the pound of coal consumed; a quantity quite absurd.

It would therefore appear, before a proper comparison could be established between the merits of the *Thetis'* boiler and that of any other boiler, a correct trial of the former would be necessary. In the meantime we have but to consider that the report of Prof. Rankine was based on one hour's consumption of, say 230 lbs. of coal, and compare that with a mass of boiler, water, and fire-brick weighing 20 tons, at a temperature of, say 300°, it is evident that the mass of heat in proportion to the coal consumed is so great that no conclusion should be made from such an experiment; also, that when the quantity of coal said to be consumed, viz., 230 lbs., is compared with area of fire-grate, say 40 square feet, it is evident that the result should not be depended upon, as no ordinary comparisons could be made of the condition of the fires before and after the experiment. In conclusion, let me ask of every one present to consider the trial trips of steamships and boilers in their true light, and before drawing any inference from such trials, make a perusal of results obtained from sea voyages. The evaporative power and economy of boilers is one of the most important subjects for this Society to consider. We need only to refer to the report drawn up by the Steam Shipping Committee of the British Association to show how mixed up the question of the relative efficiency of the boilers and engines is generally considered. Indeed, the American navy returns form the only reports showing the evaporative power of the boilers in this list, and the whole merit of a good evaporating boiler is often sacrificed to the character of the engines. With regard to the *Thetis*, I would recommend any mistake to be remedied as soon as possible, as there are many contracts of a most responsible nature formed in consequence of this report, that will lead to serious loss and disappointment to the steam shipping interest and to the engineering profession of this country.

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*A Sheet of Paper Four Miles Long.**

A sheet of tissue paper has been exhibiting at Colyton, Devonshire. It measures in length four miles, being 21,000 feet long, and is in breadth 6 feet 3 inches. The weight of it is but 196 pounds. It was manufactured in twelve hours.

*From the London Builder, No. 906.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. FARADAY, D. C. L., F. R. S.

LECTURE VI. (Jan. 7, 1860.)—*The Correlation of the Physical Forces.*

We have frequently seen during the course of these lectures, that one of those powers or forces of matter of which I have written the names on that board, has produced results which are due to the action of some other force. Thus, you have seen the force of electricity acting in other ways than in attracting; you have also seen it combine matters together or disunite them by means of its action on the chemical force; and in this case, therefore, you have an instance in which these two powers are related. But we have other and deeper relations than these; we have not merely to see how it is that one power affects another—how the force of heat affects chemical affinity, and so forth, but we must try and comprehend what relation they bear to each other, and how these powers may be changed one into the other; and it will to-day require all my care, and your care too, to make this clear to your minds. I shall be obliged to confine myself to one or two instances, because to take in the whole extent of this mutual relation and conversion of forces would surpass the human intellect.

In the first place, then, here is a piece of fine zinc-foil, and if I cut it into narrow strips and apply the power of heat to it, admitting the contact of air at the same time, you will find that it burns; and then, seeing that it burns, you will be prepared to say that there is chemical action taking place. You see all that I have to do is to hold the piece of zinc at the side of the flame so as to let it get heated, and yet to allow the air which is flowing in to the flame from all sides to have access to it;—there is the piece of zinc burning just like a piece of wood, only brighter. A part of the zinc is going up into the air in the form of that white smoke, and part is falling down on to the table. This, then, is the action of chemical affinity exerted between the zinc and the oxygen of the air. I will show you what a curious kind of affinity this is by an experiment which is rather striking when seen for the first time. I have here some iron filings and gunpowder, and will mix them carefully together with as little rough handling as possible; now we will compare the combustibility, so to speak, of the two. I will pour some spirit of wine into a basin and set it on fire; and having our flame, I will drop this mixture of iron filings and gunpowder through it, so that both sets of particles will have an equal chance of burning. And now tell me which of them it is that burns. You see a plentiful combustion of the iron filings; but I want you to observe that though they have equal chances of burning, we shall find that by far the greater part of the gunpowder remains untouched; I have only to drain off this spirit of wine and let the powder which has gone through the flame dry, which it will do in a few minutes, and I will then test it with a lighted match. So ready is the iron to burn,

* From the Lond. Chemical News, No. 10.

that it takes, under certain circumstances, even less time to catch fire than gunpowder. [As soon as the gunpowder was dry Mr. Anderson handed it to the Lecturer, who applied a lighted match to it, when the sudden flash showed how large a proportion of gunpowder had escaped combustion when falling through the flame of alcohol.]

These are all cases of chemical affinity, and I show them to make you understand that we are about to enter upon the consideration of a strange kind of chemical affinity, and then to see how far we are enabled to convert this force of affinity into electricity or magnetism, or any other of the forces which we have discussed. Here is some zinc (I keep to the metal zinc as it is very useful for our purpose), and I can produce hydrogen gas by putting the zinc and sulphuric acid together as they are in that retort; there you see the mixture which gives us hydrogen—the zinc is pulling the water to pieces and setting free hydrogen gas. Now we have learned by experience that if a little mercury is spread over that zinc, it does not *take away* its power of decomposing the water, but *modifies* it most curiously. See how that mixture is now boiling, but when I add a little mercury to it the gas ceases to come off. We have now scarcely a bubble of hydrogen set free, so that the action is suspended for the time. We have not *destroyed* the power of chemical affinity, but modified it in a wonderful and beautiful manner. Here are some pieces of zinc covered with mercury exactly in the same way as the zinc in that retort is covered, and if I put this plate into sulphuric acid I get no gas, but this most extraordinary thing occurs, that if I introduce along with the zinc another metal which is *not* so combustible, then I reproduce all the action. I am now going to put to the amalgamated zinc in this retort some portions of copper wire (copper not being so combustible a metal as the zinc), and observe how I get hydrogen again, as in the first instance—there, the bubbles are coming over through the pneumatic trough, and ascending faster and faster in the jar; the zinc, so to speak, is acting by reason of its contact with the copper.

Every step we now take brings us to a knowledge of new phenomena. That hydrogen which you now see coming off so abundantly does not come from the zinc as it did before, *but from the copper.* Here is a jar containing a solution of copper. If I put a piece of this amalgamated zinc in it, and leave it there, it has hardly any action, and here is a plate of platinum which I will immerse in the same solution, and might leave it there for hours, days, months, or even years, and no action would take place. But now I put them both in together, and let them touch each other (Fig. 1). See what a coating of copper there is immediately thrown down on the platinum. Why is this? The platinum has no power of itself to reduce the metal from that fluid, but it has in some mysterious way received this power by its contact with the metal zinc. Here, then, you see a strange transfer of chemical force from one metal to another—the chemical force from the zinc is transferred, and made over to the platinum by the mere association of the two metals. I might take instead of the platinum, a piece of copper or silver, and it would have no action of its own on

this solution, but the moment the zinc was introduced and touched to the other metal, then the action would take place, and it would become covered with copper. Now, is not this most wonderful and beautiful to see? we still have the identical chemical force of the particles of zinc acting, and yet in some strange manner we have power to make that chemical force, or something it produces, travel from one place to another—for we do make the chemical force travel from the zinc to the platinum by this very curious experiment of using the two metals in the same fluid in contact with each other.

Fig. 1. Fig. 2.

Let us now examine these phenomena a little more closely. Here is a drawing (Fig. 2) in which I have represented a vessel containing the acid liquid and the slips of zinc and platinum or copper, and I have shown them touching each other *outside* by means of a wire coming from each of them (for it matters not whether they touch in the fluid or outside—by pieces of metal attached they still by that communication between them, have this power transferred from one to the other). Now, if instead of using only one vessel, as I have shown there, I take another, and another, and put in zinc and platinum, zinc and platinum, zinc and platinum, and connect the platinum of one vessel with the zinc of another, the platinum of this vessel with the zinc of that, and so on, we should only be using a series of these vessels instead of one. This we have done in that arrangement which you see behind me. I am using what we call a Grove's voltaic battery, in which one metal is zinc and the other platinum, and I have as many as forty pairs of these plates all exercising their force at once in sending the whole amount of chemical power there evolved through these wires under the floor and up to these two rods coming through the table. We need do no more than just bring these two ends in contact, when the spark shows us what power is present; and what a strange thing it is to see that this force is brought away from the battery behind me, and carried along through these wires. I have here an apparatus (Fig. 3) which Sir Humphry Davy constructed many years ago, in order to see whether this power from the voltaic battery caused bodies to attract each other in the same manner as the ordinary electricity did. He made it in order to ex-

Fig. 3.

periment with his large voltaic battery, which was the most powerful then in existence. You see there are in this glass jar two leaves of gold, which I can cause to move to and fro by this rack work. I will connect each of these gold leaves with separate ends of this battery, and if I have a sufficient number of plates in the battery I shall be able to show you that there will be some attraction between those leaves even before they come in contact; if I bring them sufficiently near when they are in communication with the ends of the battery, they will be drawn gently together, and you will know when this takes place, because the power will cause the gold leaves to burn away, which they could only do when they touched each other. Now I am going to cause these two leaves of gold to approach gradually, and I have no doubt that some of you will see that they approach before they burn, and those who are too far off to see them approach will see by their burning that they have come together. Now they are attracting each other, long before the connexion is complete, and there they go! burnt up in that brilliant flash, so strong is the force. You thus see, from the attractive force at the two ends of this battery, that these are really and truly electrical phenomena.

Now let us consider what is this spark. I take these two ends and bring them together, and there I get this glorious spark like the sunlight in the heavens above us. What is this? It is the same thing which you saw when I discharged the large electrical machine, when you saw one single bright flash; it is the same thing, only *continued*, because here we have a more effective arrangement. Instead of having a machine which we are obliged to turn for a long time together, we have here a *chemical* power which sends forth the spark—and it is wonderful and beautiful to see how this spark is carried about through these wires. I want you to perceive, if possible, that this very spark and the heat it produces (for there is heat), is neither more nor less than the chemical force of the zinc—its *very* force carried along wires and conveyed to this place. I am about to take a portion of the zinc and burn it in oxygen gas for the sake of showing you the kind of light produced by the actual combustion in oxygen gas of some of this metal. [A tassel of zinc-foil was ignited at a spirit lamp and introduced into a jar of oxygen, when it burnt with a brilliant light.] That shows you what the affinity is when we come to consider it in its energy and power. And the zinc is being burned in the battery behind me at a much more rapid rate than you see in that jar, because the zinc is there dissolving and *burning*, and produces here this great electric light. That very same power which in that jar you saw evolved from the actual combustion of the zinc in oxygen is carried along these wires and made evident here, and you may if you please consider that the zinc is burning in those cells, and that *this* is the light of that burning [bringing the two poles in contact and showing the electric light]; and we might so arrange our apparatus as to show that the amounts of power evolved in either case are identical. Having thus obtained power over the chemical force, how wonderfully we are able to convey it from place to place; when we use gunpowder for explosive purposes, we can send

into the mine chemical affinity by means of this electricity; not having provided fire beforehand, we can send it in at the moment we require it. Now here (Fig. 4) is a vessel containing two charcoal points, and I bring it forward as an illustration of the wonderful power of conveying this force from place to place. I have merely to connect these by means of wires to the opposite ends of the battery, and bring the points in contact. See! what an exhibition of force we have. We have exhausted the air so that the charcoal cannot burn, and therefore the light you see is really the burning of the zinc in the cells behind me—there is no disappearance of the carbon, although we have that glorious electric light; and the moment I cut off the connexion it stops. Here is a better instance to enable some of you to see the certainty with which we can convey this force where, under ordinary circumstances, chemical affinity would not act. We may absolutely take these two charcoal poles down under water, and get our electric light there;—there they are in the water, and you observe when I bring them into connexion we have the same light as we had in that glass vessel.

Fig. 4.

Now, besides this production of light we have all the other effects and powers of burning zinc. I have a few wires here which are not combustible, and I am going to take one of them, a small platinum wire, and suspend it between these two rods which are connected with the battery, and when contact is made at the battery see what heat we get (Fig. 5). Is not that beautiful?—it is a complete bridge of power. There is metallic connexion all the way round in this arrangement, and where I have inserted the platinum, which offers some resistance to the passage of the force, you see what an amount of heat is evolved,—this is the heat which the zinc would give if burnt in oxygen, but as it is being burnt in the voltaic battery it is giving it out at this spot. I will now shorten this wire for the sake of showing you that the shorter the obstructing wire is, the more and more intense is the heat, until at last our platinum is fused and falls down, breaking off the circuit.

Fig. 5.

Fig. 6.

Here is another instance. I will take a piece of the metal silver and place it on charcoal connected with one end of the battery, and lower the other charcoal pole on to it—

see how brilliantly it burns (Fig. 6). Here is a piece of iron on the charcoal, see what a combustion is going on; and we might go on in this way burning almost every thing we placed between the poles. Now, I want to show you that this power is still chemical affinity—that if we call the power which is evolved at this point *heat* or *electricity*, or any other name referring to its source, or the way in which it travels, we still shall find it to be chemical action. Here is a colored liquid which can show by its change of color the effects of chemical action; I will pour part of it into this glass, and you will find that these wires have a very strong action. I am not going to show you any effects of combustion or heat, but I will take these two platinum plates, and fasten one to the one pole and the other to the other end, and place them in this solution, and in a very short time you will see the blue color will be entirely destroyed. See, it is colorless now—I have merely brought the end of these wires into the solution of indigo, and the power of electricity has come through these wires and made itself evident by its chemical action. There is also another curious thing to be noticed now we are dealing with the chemistry of electricity, which is that the chemical power which destroys the color is only due to the action on one side. I will pour some more of this sulphindigotic acid into a flat dish, and will then make a porous dyke of sand separating the two portions of fluid into two parts (Fig. 7), and now we shall be able to see whether there is any difference in the two ends of the battery, and which it is that possesses this peculiar action. You see it is the one on my right hand which has the power of destroying the blue, for the portion on that side is thoroughly bleached, while nothing has apparently occurred on the other side. I say *apparently*, for you must not imagine, that because you cannot perceive any action none has taken place.

Fig. 7.

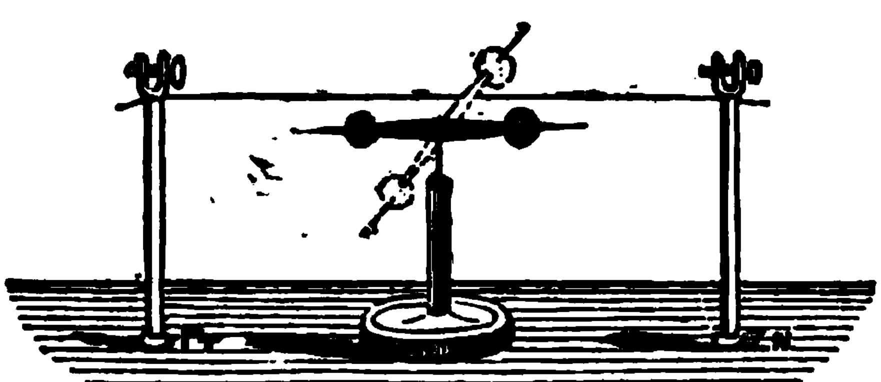
Here we have another instance of chemical action. I take these platinum plates again and immerse them in this solution of copper from which we formerly precipitated some of the metal, when the platinum and zinc were both put in it together. You see that these two platinum plates have no chemical action of any kind, they might remain in the solution as long as I liked, without having any power of themselves to reduce the copper; but the moment I bring the two poles of the battery in contact with them, the chemical action which is there transformed into electricity and carried along the wires, again becomes chemical action at the two platinum poles, and now we shall have the power appearing on the left hand side, and throwing down the copper in the metallic state on the platinum plate; and in this way I might give you many instances of the extraordinary way in which this chemical action or electricity may be carried about. That strange nugget of gold, of which there is a model in the other room, and which has an interest of its own in the natural history of gold, and which came from Ballarat, and was worth £8000 or £9000 when it was melted

down last November, was brought together in the bowels of the earth, perhaps ages and ages ago, by some such power as this. And there is also another beautiful result dependent upon chemical affinity in that fine lead-tree, the lead growing and growing by virtue of this power. The lead and the zinc are combined together in a little voltaic arrangement, in a manner far more important than the powerful one you see here, because in nature these minute actions are going on for ever, and are of great and wonderful importance in the precipitation of metals and formation of mineral veins, and so forth. These actions are not for a limited time, like my battery here, but they act for ever in small degrees, accumulating more and more of the results.

I have here given you all the illustrations that time will permit me to show you of chemical affinity producing electricity, and electricity again becoming chemical affinity. Let that suffice for the present; and let us now go a little deeper into the subject of this chemical force, or this electricity—which shall I name first?—the one producing the other in a variety of ways. These forces are also wonderful in their power of producing another of the forces we have been considering, namely, that of magnetism, and you know that it is only of late years, and long since I was born, that the discovery of the relations of these two forces of electricity and chemical affinity to produce magnetism have become known. Philosophers had been suspecting this affinity for a long time, and had long had great hopes of success—for in the pursuit of science we first start with hopes and expectations; these we realize and establish never again to be lost, and upon them we found new expectations of further discoveries, and so go on pursuing, realizing, establishing, and founding new hopes again and again.

Now observe this: here is a piece of wire which I am about to make into a bridge of force, that is to say, a communicator between the two ends of the battery. It is copper wire only, and is therefore not magnetic of itself. We will examine this wire with our magnetic needle

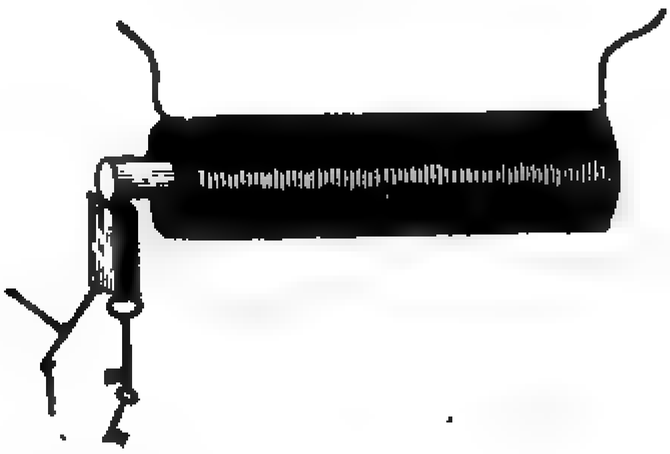
Fig. 8.



(Fig. 8), and though connected with one extreme end of the battery, you see that before the circuit is completed it has no power over the magnet. But observe it when I make contact; watch the needle, see how it is swung round, and notice how indifferent it becomes if I break contact again; so you see we have this wire evidently affecting the magnetic needle under these circumstances. Let me show you that a little more strongly. I have here a quantity of wire which has been wound into a spiral, and this will affect the magnetic needle in a very curious manner, because, owing to its shape, it will act very like a real

magnet. The copper spiral has no power over that magnetic needle at present, but if I cause the electric current to circulate through it, by bringing the two ends of the battery in contact with the ends of the wire which forms the spiral, what will happen? Why one end of the needle is most powerfully drawn to it; and if I take the other end of the needle it is repelled; so you see I have produced exactly the same phenomena as I had with the bar magnet,—one end attracting and the other repelling. Is not this then curious to see that we can construct a magnet of copper? Furthermore, if I take an iron bar, and put it inside the coil, so long as there is no electric current circulating round, it has no attraction,—as you will observe if I bring a little iron filings or nails near the iron. But now if I make contact with the battery they are attracted at once. It becomes at once a

Fig. 9.



powerful magnet, so much so that I should not wonder if these magnetic needles on different parts of the table pointed to it. And I will show you by another experiment what an attraction it has. This piece and that piece of iron, and many other pieces are now strongly attracted (Fig. 9), but as soon as I break contact the power is all gone and they fall. What then can be a better or a stronger proof than this of the relation of the powers of magnetism and electricity? Again, here is a little piece of iron which is not yet magnetized. It will not at present take up any one of these nails; but I will take a piece of wire and coil it round the iron (the wire being covered with cotton in every part so that it does not touch the iron), so that the current must go round in this spiral coil; I am, in fact, preparing an *electro-magnet* (we are obliged to use such terms to express our meaning, because it is a magnet made by electricity,—because we produce by the force of electricity a magnet of far greater power than a permanent steel one). It is now completed, and I will repeat the experiment which you saw the other day, of building up a bridge of iron nails; the contact is now made and the current is going through; it is now a powerful mag-

Fig. 10.

net; here are the iron nails which we had the other day, and now I have brought this magnet near them they are clinging so hard that I can scarcely move them with my hand (Fig. 10). But when the contact is broken, see how they fall. What can show you better than such an experiment as this, the magnetic attraction with which we have endowed these portions of iron? Here again is a fine illustration of this strong power of magnetism. It is a magnet of the same sort as the one you have just seen. I am about to make a current of electricity pass through the wires which are round this iron for the purpose of showing you what powerful effects we get. Here are the poles of the magnet; and let us place on one of them this long bar of iron. You see as soon as contact is made how it rises in position (Fig. 11);

Fig. 11.

and if I take such a piece as this cylinder, and place it on, wo be to me if I get my finger between; I can roll it over, but if I try to pull it off, I might lift up the whole magnet, but I have no power to overcome the magnetic power which is here evident. I might give you an infinity of illustrations of this high magnetic power. There is that long bar of iron held out, and I have no doubt if I were to examine the other end I should find that it was a magnet. See what power it must have to support not only these nails but all these lumps of iron hanging on to the end. What then can surpass these evidences of the change of chemical force into electricity, and electricity into magnetism? I might show you many other experiments whereby I could obtain electricity and chemical action, heat and light from a magnet, but what more need I show you to prove the universal correlation of the physical forces of matter, and their mutual conversion one into another?

And now let us give place as juveniles to the respect we owe to our elders; and for a time let me address myself to those of our seniors who have honored me with their presence during these lectures. I wish to claim this moment for the purpose of tendering our thanks to them, and my thanks to you all for the way in which you have borne the inconvenience that I at first subjected you to. I hope that the insight which you have here gained into some of the laws by which the universe is governed, may be the occasion of some amongst you turning

your attention to these subjects; for what study is there more fitted to the mind of man than that of the physical sciences? And what is there more capable of giving him an insight into the actions of those laws, a knowledge of which gives interest to the most trifling phenomenon of nature, and makes the observing student find

> "——tongues in trees, books in the running brooks,
> Sermons in stones, and good in every thing."

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*Patent Steel Plates.** By DAVID LIVINGSTONE.

River Zambesi, East Africa, 12th January, 1860.

SIR:—The insertion of the following note in the *Journal of the Society of Arts* may prove of public service in preventing any other expedition trusting to a vessel built of the "patent steel plates," which have caused us so much toil, loss of time, and annoyance.

It is probable that there are purposes to which these patent steel plates might be applied with great advantage, but eighteen months experience in a steam punt constructed of this material, has proved that the substance cannot be trusted in tropical waters. Whatever may be the process by which the plates are converted into steel, a very remarkable decomposition soon takes place when exposed to the heat and moisture of this climate, and a considerable portion of the plate becomes what possibly is the black oxide of iron. In our case, the whole vessel was painted thoroughly, inside and outside, with Peacock's patent paint while on the deck of another vessel in the voyage out. But this proved no protection, for a process of decomposition began on both surfaces, altogether different from the common rust of iron. Scales of a jet black color were formed, and when detached the plates were found to be as smooth and black as if they had left the rollers but an hour before. The scales are black in their substance, too, and strongly magnetic. The paint, firmly adherent on the outer surface, showed that it had failed to prevent the process, and curiously enough, the rivets, which are probably of common steel, neither rusted nor decomposed. For a considerable time the process of scaling off and leaving a smooth, black, and even shining surface, made us believe that the plates were suffering no harm by exposure to the weather. Friction had no effect in wearing them. But the decomposition was going on at the same rate inside; blisters, also, were formed, and at the bottom of each there was a minute hole right through, and at the end of twelve months the removal of the internal surface scale left us with plates as thin as wafers, and so full of small holes our wretched craft might have been converted into a coffee strainer for the entire Society of Arts. The plates were only one-sixteenth of an inch in thickness at the beginning, and the internal scales are one-thirty-second of an inch. The framework being of the flimsiest contract style, any attempt at mending involving hammering or wedging would have been putting a new piece into an old garment, so we had to resort to puddling her with stiff clay. This served for a while, but the holes becoming too large, we were obliged to run down to the sea, and with the assistance of the tides,

*From the Journal of the Society of Arts, No. 406.

get her out of the water. By digging the sand from beneath, we reached the worst places, and the engineers, Messrs. Rae and Hill, assisted by men from H. M. S. *Lynx*, put planks outside and inside, with plies of canvass and white lead, sandwich fashion, and guaranteed her to float any time between three days and six weeks. New leaks, however, forced us to beach before the first period mentioned, and though rather annoyed at being kept tinkering, instead of doing good service to the cause of African civilization, we must, as we have often done with disagreeables before, "put up with it."

No advantage whatever has been gained by the employment of these steel plates. The contractor intended that by their use the vessel should draw thirteen inches only, but when we tried her fairly out here in salt water, without fuel, gear, crew, or water in the boiler, she drew twenty-three inches, and her paddle floats are, of course, ten inches too deep. It was promised that she could carry from ten to twelve tons, but four tons bring her down to 2 ft. 7 ins. and within a few inches of the paddle wheel shaft, while six tons would sink her altogether.

Nor have we gained the least in speed, for, instead of "ten knots, at least," promised, we have to be content with a top speed of $3\frac{1}{2}$. This may in part be owing to the peculiar form adopted—an imitation of the Niger canoes, *i. e.*, long, narrow, and turned up at the ends. The negro reasons for this shape are sensible enough. They cannot make them broader than the trees, and make up in length what they cannot have in breadth, and they are turned up at the ends to avoid the shock which would be felt in coming to a bank, were they not made to slide up. These reasons are not so very recondite as to induce us to forsake the wave line of Mr. Scott Russell surely. Here we often see canoes made out of crooked trees, and as they are simply hollowed out, the canoe retains the bends of the stock. Some future contractor, if using other people's money, may infer that these crooked canoes are exactly suited for turning round corners, instead of inferring that the owners had no straight trees near the river.

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*On Foot Valves in Condensers and Air Pumps.**

The subject of foot valves in air pumps has, by engineers, been too much overlooked. It is of the greatest importance in marine engines, particularly in propeller engines, where the machinery is applied direct to the propeller shaft. Captain Carlsund, in Motala, I believe was the first engineer who paid attention to the proper arrangement in air pumps and foot valves; he applies his machinery with the air pump direct to the propeller shaft, making 100 to 140 revolutions per minute, and is found to work exceedingly well, while in America and England they have been obliged to gear the air pump down to a slower motion, or when attempting to apply it direct to direct action machinery, it has sometimes ended in a total destruction of the whole; the true cause of the blunder has been concealed and made over and over again.

The disproportion of foot valves has caused the loss of millions of

* From the Lond. Artisan, Oct., 1860.

dollars in America; for instance, the first engines on the frigate *San Jacinto*, U. S. N., broke down from the disarrangements of the air pumps. The *La Fayette's* engines, which I believe had the worst air pumps ever constructed for the purpose, broke down from the same cause; also, the *City of Petersburg*, and others, all American first-class steamers.

When the air pump is working, the water is forced through the foot valve by the pressure or the deficiency of vacuum in the condenser. Every pound of pressure per square inch balances a column of water of about 27 inches high; for instance, if the vacuum in the condenser is 24 inches of mercury, which is termed 12 pounds per square inch, and the atmospheric pressure being 14·75, then $14{\cdot}75-12=2{\cdot}75$ lbs., which will be the pressure per square inch in the condenser, and $2{\cdot}75\times 27=74{\cdot}25$ inches, or 6:2 feet, the head, which presses the water through the foot valve into the air pump. According to the relative position of the condenser and air pump, there may be an additional head, as when the water level in the condenser is above the air pump piston.

I will here endeavor to give some formulæ, by which to determine the area of foot valves, and size of air pumps, which will be found to be of the greatest importance for propeller engines.

D = diameter of steam cylinder in inches.
S = stroke of piston in inches, double acting.
d = diameter of air pump in inches.
s = stroke of air pump piston in inches.
a = area of foot valves in square inches.
n = number of double strokes of the air pump piston per minute, when the air pump is applied direct to the engines.
m = co-efficient for friction and resistance to the water in passing through the foot valve, estimated to 0·6 to 0·7.
n = pressure in the condenser, or deficiency of vacuum in pounds per square inch.
T = temperature of the exhaust steam, Fahrenheit's scale.
k = specific volume of the exhaust compared with water.

Assuming the temperature of the condensing water 100°, and the injection water 50° Fahrenheit's scale, we shall have the following formulæ:

$$\left.\begin{aligned} d&=0{\cdot}326\,D\sqrt{\frac{S\,(890+T)}{k\,s}},\\ s&=0{\cdot}106\,D^2\,\frac{S\,(890+T)}{k\,d^2},\end{aligned}\right\}\text{ Single acting air pumps.}$$

$$\left.\begin{aligned} d&=0{\cdot}231\,D\sqrt{\frac{S\,(890+T)}{k\,s}},\\ s&=0{\cdot}053\,D^2\,\frac{S\,(890+T)}{k\,d^2},\end{aligned}\right\}\text{ Double acting air pumps.}$$

$$a=\frac{D^2\,S\,n\,(890+T)}{23{,}000\,m\,k\,\sqrt{p}}\text{ area of foot valve.}$$

By the last formula, it appears, the proper area of the foot valve is

independent of the capacity of the air pump,—such is actually the case; if the foot valve is made too small the air cannot pump water enough for a good vacuum, however large it may be. It is most frequently the case in propeller engines that the air pump is too large and the foot valve too small.

Example.—A single acting air pump is to be constructed for an engine of

$D = 75{\cdot}75$ inches, the diameter of cylinder.
$S = 36$ inches, the stroke of piston.

Steam pressure to be 20 lbs. per square inch, expanded $\frac{1}{2}$; vacuum in the condenser to be 12·75 lbs., or $p = 2$; stroke of the air pump piston to be $s = 18$ inches. Required, the diameter of the air pump d, and area of the foot valve a?

Steam pressure, $20 + 15 = 35$ lbs.; expanded one-half $= 17{\cdot}5$ lbs., the pressure of the exhaust steam; temperature $T = 221°$, and $k = 1440$ the specific volume. The diameter of the air pump will be

$$d = 0{\cdot}326 \times 75{\cdot}75 \sqrt{\frac{36\,(890 + 221)}{1440 \times 18}} = 30{\cdot}64 \text{ inches.}$$

The air pump making $n = 45$ double strokes per minute, area of the foot valve will be

$$a = \frac{75{\cdot}75^2 \times 36 \times 45\,(890 + 221)}{23{,}000 \times 1440 \times 0{\cdot}64 \times \sqrt{2}} = 344 \text{ square inches.}$$

The dimensions in this example are similar to that of the engines in the line-of-battle ship *Rattvisan*, except the air pumps, are there 42 inches diameter, and area of the foot valve is only 273 square inches, while this example gives only 30·64 diameter, and 344 square inches of foot valve.

This, I believe, is an error in all the upright trunk propeller engines.

Referring to the *Artizan* for November, 1856, it will be found that the United States steam frigate *Merrimac* suffered the breaking down of her foot valves on her passage from America to England. The *Artizan* states that the original foot valves were only 176 square ins., that new ones were replaced of 230 square inches, while the frigate laid at Southampton, and that about one pound of vacuum was gained with the increased foot valve. Dimensions of the engines of the *Merrimac* are, diameter of cylinders 72 inches, stroke of piston 3 feet, diameter of air pumps 22 inches, stroke of air pump 3 feet double acting.

When, by this calculation and formulæ, the area of the foot valve becomes nearly the same size, or greater than the area of the air pump piston, the latter must be made double acting, and half the calculated area of the foot valve to be applied at each end of the air pump. In very high velocity the area of the foot valve may become greater than the area of the double acting air pump; in such cases it is necessary to make plungers, so that the section area of the space in which the plunger moves is greater than the area of the foot valve, and the operation will be rendered efficient.

*On Etching.**

Ornamentation on metals, glass, and porcelain, has come into considerable use; and, believing as we do, that such work would not only be pleasant to amateurs, but might also be useful to others, we think that a few brief and practical notes on the subject may not be out of place.

First, as regards copper plates—which in many respects have an advantage over steel for the use of amateurs,—procure a thin plate, properly polished on the surface, at any of the regularly established copper-smiths. These can be had of the size of several feet down to a few inches. The surface of the plate being bright and free from tarnish, remove all grease with great care by washing with spirit of turpentine and then rubbing with very fine whitening and wash-leather. Care must be taken not to scratch the plate.

Having got rid of all grease, fix a hand-vice to one corner or some other convenient part of the plate; it is then ready for the reception of the etching-ground—a preparation chiefly composed of asphaltum, pitch, and virgin wax; there is, however, a great art in making this sufficiently plastic, so as to admit of its being properly spread upon the plate when heated. It is better for ordinary purposes to purchase it at the copper-smith's or tool-shop, where a supply can be had for about one shilling. A dabber, for the purpose of laying the ground on the plate, is also necessary. This is of a mushroom shape, and composed outwardly of very fine silk or kid leather, free from grease; the inside is padded with wool. This can be readily made by any person who has seen one of them. In order to prevent any grit or impurity which may chance to be in the etching-ground, it is better to tie it in silk. For the purpose of heating the plate, a hot iron, or a spirit lamp, placed below an iron frame on which the plate may rest, or other contrivance may be used. Care is to be taken to make as little dust as possible. The metal must not be allowed to get too hot, for that would burn the etching-ground, and prevent it from sufficiently resisting the acid. The plate being of a proper heat, by drawing the etching-ground over the face, a small quantity will be lodged upon it. This in the first instance is uneven; but may be spread in a flat, thin, even manner. Every part must be covered by the ground, or else the acid would leave such places as are bare liable to be corroded into holes. The ground, when this is spread on the surface, is of a light brown color, so delicate that it is difficult to see any pencil outline which might be transferred, or properly to see the scratches made by the etching-needle. In order to darken this, it is necessary, while the plate and etching-ground are still warm, to smoke it by the flame of a wax taper or candle. The flame must be kept moving about, and not allowed to touch the plate so closely as to burn the ground.

These operations, although simple, require some little practice and experience; and it is, perhaps, a good plan either to take a lesson or two in ground-laying, and the other parts of this process, from an en-

* From the Lond. Builder, No. 918.

graver, or else to get one of this profession to lay the ground and bite in the plate when etched.

The ground having been made ready and the plate cold, an outline of the subject, prepared on ordinary or tracing paper, should be damped and transferred by means of pressure. The best way to manage this is to take it to a copper-plate printer, who will do it effectually for a few pence; for those living in the country where such convenience cannot properly be had, this transfer can be made by one of the ordinary letter copying machines, or by going very delicately over the back of the outlines with a pencil or other instrument which is not too sharp.

This having been done by means of an etching-point, which can be had at the tool-makers, the design can be readily scratched upon the plate. Attention is needed to mark the lines quite through the ground. The hand should also be prevented from coming in contact with the ground, and all unnecessary scratches be carefully avoided. This may, to a considerable extent, be done, by forming a bridge of a flat ruler, supported by pieces of card-board or folded paper.

Wherever the etching-ground has been passed through by the etching-needle, that part is liable to be eaten into a line by the application of acid; on no other portion however, if properly done, should the acid work.

It being necessary to cover the etching with an even depth of diluted acid (from a quarter to half an inch), in order to produce equality in the *biting*, it is needed to form a wall of wax round the margin of the work. The best material for this is bees-wax with a small part of Burgundy-pitch added, and then the mixture boiled until the whole is well mixed. This, when needed for use, should be put into warm water, and then it can be readily raised round the plate and pressed down by the fingers, and after that more firmly by the handle of the etching-point, so that a sort of tank is formed, which will contain the acid as long as it may be necessary.

With the greatest care scratches may be made, or it may be necessary to erase parts, or the wax wall may not be sufficiently tight. In order to remedy this, turpentine-varnish, or the ordinary "Brunswick black" used for stoves, may be employed, thinned to a proper extent by turpentine, and applied with a black-lead pencil.

For the purpose of "biting in" the plate, as the engravers call it, nitrous acid of the purest description should be mixed—one part of acid and three parts water—which should be stirred up with a feather or pencil; soon the lines will be covered with minute globules; and, in proportion to the time the acid is allowed to remain, the etched lines will become thicker and deeper.

As a matter of course, in order to produce a delicate and refined effect a variety of thicknesses of line is desirable; and, although much can be done by the pressure of the point, by hatching, doubling lines, &c., it is in most cases necessary to allow the acid different times of action; for instance, it will be desirable to keep distant mountains and landscape thin, and to bring out the foreground by bold and deep lines. In order to manage this, the acid must be poured off into a vessel for further use, and then the plate must be well washed with clear water,

and afterwards dried with a bellows or other means; then such parts of the etching as are of sufficient depth should be covered with the varnish in the same manner as the blemishes to which we have referred. This operation may be performed any number of times, each time washing and drying the plate; this must be also done when the biting is completed; and, then, by gently heating the back of the plate, the wall may be drawn off, and by means of a little spirit of turpentine and oil, the surface of the plate may be cleared of the etching-ground. There are other operations, such as re-biting, re-etching (by touching with the graver), and by working with a point without the use of acid, &c., &c.; these, however, would require much space to describe, and this we will not just now do, as it is more particularly our object in mentioning the above to make operations which might be useful in many manufactures more readily understood.

In the same manner, but with the use of different acids, and on any scale, etching may be applied to steel, iron, brass, glass, and, lately, we are told, to porcelain. For steel, nitric acid very largely diluted with pyroligneous acid until it does not taste much stronger than vinegar, is best. On brass we have seen diaper and other ornaments produced with great clearness and rapidity in the following manner. On large works, such as monumental brasses, experience has shown that in the biting, either by nitric or nitrous acid, before a great depth is got the biting of the lines is stopped by the formation of a black oxide, which it requires a very strong preparation of nitrous and sulphuric acid to remove and keep in solution; and this after a time proves too strong, and tears up the ordinary etching-ground; it has, however, been found that turpentine-varnish, if allowed for a few days to harden, has a great resistance; and by the use of this when diapers, &c., are outlined, the raised parts may be painted with the varnish; and, when hard, the acid applied; and it is astonishing what good effect may be produced by these means. Large surfaces for the relief of foliage, figures, letters, &c., may by this means, be executed with rapidity, either for filling in with colored shellac or pigments.

The painting of these ornamental plates with varnish might be the means of affording employment to females, and probably the preparation of embossing, and otherwise ornamenting glass to be bitten by fluoric acid, might also be brought into far more extensive use than it is at present, and would also provide a certain amount of respectable labor for females.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM SEPTEMBER 1, TO SEPTEMBER 30, 1860.

Amalgamator,	G. M. Norton,	San Francisco,	Cal.	18
Amalgamators,—Quartz	Wm. H. and I. Scoville,	Chicago,	Ill.	25
Annealing Apparatus,	Joseph Worcester,	Newport,	Ky.	25
Apple Parer, Corer, and Slicer,	J. J. Parker,	Marietta,	Ohio,	11
Aqueducts,	John Osborn,	Mt. Carmel,	Conn.	4
Augers,	J. M. Hathaway,	City of	N. Y.	4
Axes to Handles,—Fastening	W. H. Livingston,	"	"	25
Barometer,	E. F. Hamann,	Collikoon,	N. Y.	18
Barrel-head Machine,	C. B. Hutchinson,	Auburn,	"	11

Bathing Tubs,—India-rubber	Ramsay & Wilson,	Grafton,	Va.	4
Bed Bottom Spring, .	H. R. Crampton, .	Lockport,	N. Y.	18
Bedstead, .	B. S. Pringle, .	Barnesville,	Ga.	4
———,—Folding Case	Ethan Whitney, .	Lynn,	Mass.	18
———,—Spring .	D. R. Lightner, .	Bucyrus,	Ohio,	4
Beehives, .	John Jacobs, .	Columbus,	"	25
Beer,—Factitious .	Ferdinand Luedke,	City of	N. Y.	25
Bending Wood, .	Spaulding & Pierce, .	Westminster,	Mass.	11
Billiard Tables,—Cushions for	H. W. Collender,	City of	N. Y.	25
Blowers, .	P. H. Roots, .	Connersville,	Ind.	25
Boards,—Machine for Thinning	Sharon Case, .	Lumpkin,	Ga.	4
Bolt,—Shutter .	Augustus Reeve, .	Allowaystown,	N. J.	18
Bombshells, .	Wm. Rice, .	Philadelphia,	Penna.	11
Bottles,—Forming Screws in	John Focer, .	Glassborough,	N. J.	18
Boots and Shoes, .	J. M. Allen, .	Fredericktown,	Ohio,	18
————,—Heel for	D. E. Somes, .	Biddeford,	Me.	18
Boot and Shoe Soles,—Cutting	L. S. Graves, .	Rochester,	N. Y.	18
Boxes,—Device for Joining	Wright Duryea, .	City of	"	11
Brick Moulds, .	Matthew Elder, .	Lansing,	Mich.	11
Broom, .	W. H. Towers, .	City of	N. Y.	4
Buckwheat, &c.,—Cleaning	J. H. Reed .	Penn Towns'p,	Penna.	4
Burglar Alarm,—Electro-mag.	Jacob Haller, .	Ann Arbor,	Mich.	25
Candles,—Moulding .	Antonio Meucci,	Richmond co.,	N. Y.	25
Cane Juice,—Sulphurous acid to	Thomas Byrne, .	Baton Rouge,	La.	4
Carpet Lining,—Making	J. R. Harrington,	City of	N. Y.	11
Carriage Jack, .	J. Card, .	Cleveland,	Ohio,	25
Carriages, .	Efner & Sperry,	Ann Arbor,	Mich.	4
——— .	Wicklin & Weaver, .	Carlinville,	Ill.	4
———,—Extension, .	J. A. Naylor, .	Rahway,	N. J.	4
Cars from one track to another,	Wm. Wharton, Jr., .	Philadelphia,	Penna.	18
Cartridges,—Metallic .	Ethan Allen, .	Worcester,	Mass.	25
Cement, .	P. A. Letourneur, .	New Orleans,	La.	11
Chains,—Link for .	G. W. N. Yost, .	Yellow Springs,	Ohio,	11
Chair for Invalids,	Chas. Messenger, .	Warren,	"	25
—— Seat, .	L. B. Batcheller,	Rochester,	N. Y.	11
Cheese,—Pressing	Wm. McAllister, .	Gerry,	"	4
——— Vats, .	Wm. Ralph, .	Holland Patent,	"	25
Clothes Frame, .	S. T. Lamb, .	N. Washington,	Ind.	18
———— .	Patrick Cody, .	Hamilton,	N. Y.	25
——— Dryer, .	H. E. Fickett, .	Glenn's Falls,	"	4
———— .	O. P. Allen, .	Rindge,	N. H.	11
Clock,—Calendar	T. T. Strode, .	Mortonville,	Penna.	25
Coffee,—Cleaning, Drying, &c.	Wm. Newell, .	Philadelphia,	Penna.	18
Compass Protractor, .	F. H. West, .	San Francisco,	Cal.	25
Condensation,—Apparatus for	Mihan & Lane, .	Boston,	Mass.	18
Corn Planters, .	W. G. Savage, .	Clinton,	Ill.	25
———— .	John Underwood,	Cameron,	"	25
———— .	L. F. Straight, .	Fairbury,	"	11
—— Shellers, .	Michael Hauseman,	Huntingdon,	Ind.	4
———— and Cleaners,	J. C. Richards, .	Lafayette,	"	25
Cotton Bales,—Iron Ties for	P. Davy, .	Portsmouth,	Ohio,	25
————,—Metallic Bands	R. W. Fenwick, .	Washington,	D. C.	25
——— Cleaners, .	S. C. Ames, .	Washington,	Ark.	11
———— .	Isaac Hayden, .	Lawrence,	Mass.	11
————	Charles Smith, .	Knoxville,	Texas,	11
——— Gins, .	H. L. Emery, .	Albany,	N. Y.	4
————,—Feeders for	S. Z. Hall, .	Sequin,	Texas,	11
——— Scrapers, .	J. C. Teague, .	Center Hill,	Miss.	4
——— Seed,—Hulling	Joel Tiffany, .	Syracuse,	N. Y.	18
———— Planters, .	O. L. Gibson, .	Fort Bend co.,	Texas,	11
Couplings,—Railroad Car	John McKinney,	Lansing,	Mich.	4
———— for City Railroads,	Collyear & Patterson,	Philadelphia,	Penna.	11

Cultivators,	T. E. C. Brinly,	Louisville,	Ky.	25
————	Gilbert & Weston,	Starkville,	Ga.	4
————	Wm. H. and L. Seymour,	Weymouth,	Ohio,	11
————	J. F. Wood,	Houma,	La.	25
————	G. W. N. Yost,	Yellow Springs,	Ohio,	4
————,—Cotton	W. W. Golsan,	Autaugaville,	Ala.	4
————————	J. C. Sellers,	Woodville,	Miss.	25
Curtain Fixture,	J. F. Hall,	Bangor,	Me.	4
————————	J. C. Whitwell,	City of	N. Y.	25
Dental Chairs,—Construction of	Justus Ask,	Lyons,	N. Y.	4
Dividers,—Spring	J. W. Strange,	Bangor,	Me.	11
Door Latch,	Jonathan Walton,	Brooklyn,	N. Y.	11
Doors and Gates,—Closing	Stephen Stewart,	Philadelphia,	Penna.	11
Draw-bridges,—Self-acting	Schneider & Montgomery,	Williamsport,	"	4
Egg-beater,	H. F. Drott,	Cumberland,	Md.	18
————	Nicholson & Earle,	Providence,	R. I.	25
Electro-magnets,	C. T. Chester,	City of	N. Y.	4
Electro-magnetic Apparatus,	Jerome Kidder,	"	"	18
Envelope,—Prepaid	J. B. Murray,	"	"	25
Excavating Machines,	M. B. True,	Newburyport,	Mass.	18
Faucets,	L. L. Alrich,	Carthage,	Mo.	25
————	Wm. Cleveland,	Orange,	N. J.	25
————	James Farnan,	Cleveland,	Ohio,	18
Fences,	Henry Burrows,	Georgetown,	D. C.	11
Fibrous Material,—Sheets of	Wm. Fuzzard,	Charlestown,	Mass.	18
Fire Arms,	C. F. Brown,	Warren,	R. I.	18
————,—Breech-loading	Ethan Allen,	Worcester,	Mass.	18
————,—Revolving	J. M. Cooper,	Pittsburgh,	Penna.	4
————————	Daniel Moore,	Brooklyn,	N. Y.	18
Fire-places,	C. A. Littlefield,	Covington,	Ky.	11
Floodgates,—Self-acting	G. B. Markham,	Mead's Mills,	Mich.	4
Flour,—Preparation of	Thomas Byrne,	Baton Rouge,	La.	4
Furnaces,	Mellen Battel,	Albany,	N. Y.	18
————	W. D. Thomas,	Morristown,	Vt.	4
————,—Bagasse	Jones & Charpentier,	New Orleans,	La.	18
————,—Hot-air	A. H. Bartlett,	Spuyten Duyvil,	N. Y.	18
Gas from Wood,—Making	August Schmidt,	City of	"	4
Gas Tubes,—Flexible	T. J. Mayall,	Roxbury,	Mass.	4
Gearing,—Machine	R. J. Gatling,	Indianapolis,	Ind.	18
Glass Jars,—Moulds for	R. Hemingray,	Covington,	Ky.	18
—— Moulds,	G. W. Scollay,	St. Louis,	Mo.	18
Grading Instrument,	S. L. Donnell,	S. Carroll,	Tenn.	11
Grain Cleaning Machine,	J. B. Tunison,	Ovid,	N. Y.	18
———,—Cleaning and Polishing	Plant & Raith,	St. Louis,	Mo.	18
——— Elevators,	T. H. Green,	Fon du Lac,	Wis.	4
——— Separators,	Moses Bugher,	New Philada,	Ohio,	18
————————	S. M. Wirts,	Hudson,	Mich.	11
———,—Separating & Scouring	D. S. Mackey,	Batavia,	N. Y.	18
———,—Sieves for Separating	H. W. Putney,	Lyons,	N. Y.	25
Grate Bars,	Daniel Lasher,	Brooklyn,	"	11
————	W. W. Marsh,	Alton,	Ill.	18
Griddles,	G. W. Pittock,	Union Mills,	N. Y.	11
Gun Carriage,	J. J. Walsh,	City of	"	25
Harness,—Snap Hook for	John North,	Middletown,	Conn.	18
Harrows,	M. W. House,	Cleveland,	Ohio,	4
————	Stewart Neill,	Chillicothe,	Ill.	4
Harvester Cutters,	B T. Roney,	Philadelphia,	Penna.	11
Harvesters,	H. H. Foye,	Ottawa,	Ill.	25
————	J. M. Long,	Hamilton,	Ohio,	4
————,—Rake and Reel for	McClintock Young, Jr.,	Frederick,	Md.	18

Harvesters,—Raking Appa's for	W. A. Wood, .	Hoosick Falls,	N. Y.	11
——————	C. P. Gronberg, .	Aurora,	Ill.	11
Harvesting Machines, .	Bernhard Mertz,	Burlington,	Iowa,	11
Hatchways,—Opening & Clos'g	E. C. Ford, .	City of	N. Y.	25
Hats,—Ventilating .	Arthur Maginnis,	Philadelphia,	Penna.	11
Hay Elevating Forks,	L. A. Beardsley, .	S. Edmeston,	N. Y.	11
—— Rakes, .	C. J. Fay, .	Hammonton,	N. J.	25
—— and Straw Cutters,	J. D. Felthousen, .	Mich. City,	Ind.	18
—————— .	D. H. Whittemore,	Lynchburg,	Va.	4
Heating by Hot Water,	Hunter & Geissenhainer,	City of	N. Y.	18
Heating Buildings,—Appa's for	George Marlow, .	Cincinnati,	Ohio,	11
Hemp Brakes, .	R. J. Gatling, .	Indianapolis,	Ind.	4
———— .	Ives Scoville, .	Chicago,	Ill.	25
Hops,—Preserving .	J. C. Baldwin and others,	Waterville,	N. Y.	25
Horse Collars,—Hames for	Martin Drew, .	St. Paul,	Minn.	18
Horse-powers, .	Benjamin Bogue, .	Trenton,	Iowa.	4
Horse Rakes, .	Daniel Strock, .	Chambersburg,	Penna.	11
Horses to Vehicles,—Attaching	Austin Avery, .	S. Windham,	Conn.	18
Hose,—Waterproof	H. A. Alden, .	Matteawan,	N. Y.	18
Hydrants, .	Albert Fuller, .	Cincinnati,	Ohio,	4
Jack Screws, .	E. W. Cady, .	Tomah,	Wis.	11
Journal Boxes, .	P. S. Devlan, .	Elizabethport,	N. J.	25
Lamps, .	H. J. Batchelder,	Marlboro',	Mass.	18
——— .	George Neilson, .	Boston,	"	18
——— or Torches,—Swinging	L. T. Pitkin, .	Hartford,	Conn.	18
———,—Hanging Torch	O. H. Cooper, .	City of	N. Y.	18
———,—Moulds for Glass	Joshua Jenkins,	Boston,	Mass.	18
Lifting Jack, .	George Benjamin, .	Avoca,	N. Y.	18
Lightning Rods, .	David Wooster, .	Seymour,	Conn.	4
Locks, .	J. L. Hall, .	Cincinnati,	Ohio,	25
——— .	C. F. Johnson and others,	Owego,	N. Y.	11
——— .	George Rosner, .	Rochester,	"	18
——— .	E. P. Whitney, .	Westfield,	"	4
Lock for Burglar-proof Pockets,	Wm. J. Scott, .	Albany,	"	25
——,—Portable Door	E. G. F. Arndt, .	Rondout,	"	18
Locomotive Engines, .	A. J. Graham, .	Portland,	Oregon,	4
——————,—Dischar.	John Greacen, Jr.,	City of	N. Y.	4
Looms,—Power, .	Furbush & Crompton,	Worcester,	Mass.	4
Magneto-electric Apparatus,	H. N. Baker, .	Binghampton,	N. Y.	4
Malt Kilns,—Floors for .	Henry Franz, .	Philadelphia,	Penna.	25
Manure Spreader,—Roller and	John Lyker, .	Argosville,	N. Y.	25
Meat Cutter, .	J. G. Perry, .	S. Kingston,	R. I.	18
Medicinal Extracts,—Prepar. of	A. J. Despinoy, .	Lille,	France,	18
Milk-straining Pails, .	H. Buckins, .	Canton,	Ohio,	18
Mills,—Fanning .	B. F. Roe, .	Nebraska City,	Nebr.	11
——,—Feeding Grain to .	M. H. Ferguson, .	Sunfish,	Ohio,	11
Mill-dams,—Waste Gates for	Sidney Hudson,	Milford,	Mich.	4
Millstones,—Balancing .	D. Fellenbaum, .	Lancaster,	Penna.	4
————,—Dressing	C. D. Brewer, .	Lewisburg,	"	4
————,—Hanging .	Z. McDaniel, .	Bowling Green,	Ky.	11
Miter Box, .	H. B. Nash, .	Sandy Hill.	N. Y.	11
Mop Wringer, .	C. S. Schmidt, .	City of	"	25
Mortising Machines,	H. C. Smith, .	Clarksville,	Ohio,	4
Motion,—Stopping & Changing	F. A. Pratt, .	Hartford,	Conn.	4
Mowing Machines,	Henry Marcellus,	Amsterdam,	N. Y.	4
——————,—Hand	J. M. Spencer, .	Enfield,	Me.	4
Ore Washer, .	B. O'Bryan, .	Lancaster,	Penna.	18
Paddle Wheel,—Stern .	D. K. Peoples, .	Philadelphia,	Penna.	18
Paper,—Trimming	Julius Koch, .	S. Adams,	Mass.	4
Parasols, .	Davis & Frost, .	Watertown,	Conn.	25

Patterns,—Marking Waving	Albert Moffet, .	Bristol,	Ohio,	4
Piles by Atmos. Pressure,—Driv.	W. S. Smith, .	Trenton,	N. J.	4
Pipe,—Casting .	Alfred Brady, .	City of	N. Y.	18
Pipes,—Moulding Metal	Homer Parmalee, .	Philadelphia,	Penna.	4
———,—Tapping Water	Jacob Drake, .	City of	N. Y.	18
Planes,—Moulding .	Chas. Fleming, .	Ypsilanti,	Mich.	11
Planing Machine,	H. D. Stover, .	City of	N. Y.	4
Planing Mouldings, .	Wm. Rankin, .	Providence,	Va.	11
Ploughs, .	T. E. C Brinly,	Louisville,	Ky.	4
——— .	G. W. Cunningham,	Paris,	Mo.	25
——— .	H. J. Fraser, .	Kansas City,	"	25
——— .	Walter Warren, .	Penn Yan,	N. Y.	25
——— .	W. T. Zollickoffer,	Shelbyville,	Tenn.	25
———,—Mole .	W. B. Atkinson, .	Plymouth,	Ill.	18
——— .	H. Bagley, .	Tipton,	Iowa,	18
———,—Capstans for	A. Little and others, .	Decatur,	Ill.	11
Post Holes,—Earth Borers for	A. S. Ballard, .	Mt. Pleasant,	Ind.	25
Potato Planters, .	G. W. and J. J. Kersey,	Beartown,	Penna.	25
Presses,—Anti-friction	A. H. Emery, .	City of	N. Y.	11
———,—Drop .	M. and C. Peck, .	New Haven,	Conn.	4
———,—Cotton .	P. G. Gardiner, .	City of	N. Y.	4
——— .	W. T. Opie, .	Scarboro,	Ga.	4
——— .	Maximilian Wappich,	Sacramento,	Cal.	4
Projectiles, .	J. W. Cochran, .	City of	N. Y.	25
Propulsion,—Marine	L. B. Flanders, .	Cleveland,	Ohio,	18
Propeller,—Marine .	A. E. Harding, .	Middletown,	"	11
Pumps, .	Henry Pease, .	Brockport,	N. Y.	11
——— .	G. C. Selfridge, .	N. Greenfield,	"	4
Railroads, .	B. F. Lee, .	City of	N. Y.	11
Railroad Cars,—City .	Joseph Harris, Jr., .	Roxbury,	Mass.	4
——— Frog, .	J. M. Robb, .	Charleston,	S. C.	25
———,—Substitute for	Black & Ford, .	Erie,	Penna.	25
——— Joints, .	L. B. Tyng, .	Lowell,	Mass.	11
——— Switch, .	G. E. Beach, .	Jersey City,	N. J.	25
Railroads,—Safety Guards for	Thomas Stewart,	Pittsburgh,	Penna.	11
Rakes,—Horse .	J. C. Stoddard, .	Worcester,	Mass.	11
Ranges and Stoves,	J. G. Treadwell,	Albany,	N. Y.	11
Reaping Machines, .	W. S. Stetson, .	Baltimore,	Md.	25
Reed Instrument,—Steam	G. G. Ray, .	Boston,	Mass.	4
Refrigerator, .	Kirby Spencer, .	Minneapolis,	Ind.	25
Rice,—Cleaning .	Silas Dodson, .	San Francisco,	Cal.	25
———,—Polishing .	Daniel Lombard, .	Boston,	Mass.	4
———,—Scouring .	"	"	"	4
Rifle Balls,—Moulds for .	Lewis Evans, .	Morgantown,	Va.	18
Rock-drilling Machines,	L. M. Gilmore, .	Janesville,	Wis.	11
Ruffles,—Manufacture of .	G. B. Arnold, .	City of	N. Y.	25
Saddles, .	J. H. Boyd, .	Baltimore,	Md.	25
Saddle Trees, .	S. E. Tompkins, .	Newark,	N. J.	25
Sad Iron, .	L. S. Chichester, .	City of	N. Y.	4
Sails for Vessels,—Fore-and-aft	A. C. Tibbetts, .	Rockland,	Me.	11
Salt,—Manufacture of Common	Thomas Spencer,	Syracuse,	N. Y.	25
Sap from Trees,—Collecting	E. W. Ormsbee, .	Montpelier,	Vt.	4
Sap Conductors, .	Homer Hecox, .	Rutland,	N. Y.	4
Saw Clamp, .	J. H. Dunbar, .	Plymouth,	Conn.	11
——— Frames,—Wood	Wm. H. Livingston,	City of	N. Y.	18
——— .	" .	"	"	18
——— Grinding Machine,	Wm. Dougherty,	Philadelphia,	Penna.	25
——— Teeth, .	Ira Mason, .	Berlin,	N. H.	11
Saws,—Grinding .	H. R. Burger, .	Richmond,	Va.	11
———,—Handles to Cross-cut	Isaac Pelham, .	Ithaca,	N. Y.	25
———,—Wood .	Augustus Pruyn,	Albany,	"	11
Sawing Machine,—Hoop .	Joseph Raub, .	Highland,	Penna.	11

Sawing Out Shingles,	J. R. Hall,	Brunswick,	Me.	11
School Desk,	Amos Chase,	N. Weare,	N. H.	11
School Desks,—System of	S. L. Wilkinson,	Cross Plains,	Tenn.	18
Seed Planters,	W. H. Barber,	Wolcottville,	Conn.	4
———	W. W. Golsan,	Autaugaville,	Ala.	4
———	A. F. Hines,	Washington,	D. C.	4
Seeding Machines,	Ball & Nauman,	Dayton,	Ohio,	25
———	Benjamin Barnard,	Farmington,	"	25
———	David Eldred,	Monmouth,	Ill.	25
———	A. R. Park,	Columbia,	Texas,	4
Sewing ———	G. B. & A. Arnold,	City of	N. Y.	25
———	Dwight Tracy,	Worcester,	Mass.	11
———	T. S. Washburn,	Rochester,	N. Y.	11
Sheathing Ships, &c.,	John Revere,	Boston,	Mass.	4
Shingles,—Sawing	August Pernot,	Chilton,	Wis.	4
Ship-building,	S. L. Pionnier,	City of	N. Y.	4
Ships Air Ports,	Maupin & Rooke,	Portsmouth,	Va.	18
—— Windlass,—Vertical	Charles Perley,	City of	N. Y.	11
Shirt Bosoms,	Ira Perego, Jr.,	"	"	25
Shirting,—Evening the Edges of	A. T. Underhill,	"	"	11
Shoe Lasts,	Franklin Maynard,	Cambridge,	Mass.	25
Skates,	Luther Fogg,	Boston,	"	4
Smoothing Iron and Lamp,	Leonard Bricker,	Springfield,	Ill.	11
Smut Machines,	H. W. Shipley,	Mt. Vernon,	Ohio,	11
—— and Scouring Machines,	James White,	Cleveland,	"	25
Sowing Machines,	J. L. Garlington,	Snapp'g Shoals,	Ga.	25
———	W. D. Mason,	Jarratt's Depot,	Va.	4
Spoke-shave,	Samuel Leonard,	Bridgewater,	Mass.	18
Staves,—Jointing	Wm. Robinson,	Augusta,	Ga.	11
———,—Riving and Dressing	"	"	"	11
Stables for Horses, &c.,—Safety	Wm. E. McIntire,	Salem,	Mass.	18
Stave Jointer,	Edmund Greenlee,	Summerhill t'p,	Penna.	11
—— Machines,	S. F. Gelston and others,	Buffalo,	N. Y.	25
Steam Boilers,—Grates for	F. A. Hull,	Belvidere,	Ill.	11
——— Engines,	Wallace Wells,	City of	N. Y.	11
———,—Cut-off valves	George Frost,	Brooklyn,	"	25
———,—Governors for	S. H. Miller,	Hanoverton,	Ohio,	11
———,—Oscil. Valves	George Burnham,	Pittsburgh,	Penna.	25
——— Hammers,	Thomas Beach	Freeport,	"	4
——— Heating Apparatus,	C. A. Wilson,	Cincinnati,	Ohio,	4
Steel,—Converting Iron into	E. G. Pomeroy,	City of	N. Y.	4
———	Thomas Sheehan,	Dunkirk,	"	4
Stench Trap for Sinks,	Alfred Carson,	City of	"	25
Stirrups,	D. W. Clark,	Stratford,	Conn.	11
Stoves,	W. B. Treadwell,	Albany,	N. Y.	18
———,—Cooking	Zebulon Hunt,	Hudson,	"	25
———,—Fruit Dry'g	D. C. Colby,	Newport,	N. H.	18
Stove Grate,	J. W. Parnell,	Troy,	N. Y.	25
Straw Cutters,	Wm. B. Kern,	Middlebourne,	Va.	18
———,—Feeder for	Daniel Fusig,	Rowsburg,	Ohio,	4
Street Paving,—Rammer for	Wm. Beach,	Philadelphia,	Penna.	18
Sugar-cutting Machine,	Charles Kingler,	City of	N. Y.	25
Sugar,—Refining	H. G. C. Paulsen,	"	"	18
Swifts,	M. Hemingway,	Watertown,	Conn.	18
Scythes,—Hardening	Holman & Kelly,	Slaterville,	R. I.	18
Tanning,—Apparatus for	Wm. H. Heald,	Baltimore,	Md.	11
Teaching Children,	J. J. Johnston,	Alleghany,	Penna.	4
Thread-dressing Machines,	Julius Loeb,	City of	N. Y.	11
Threshing Machines,	David Barger,	Columbia,	"	11
———	A. B. Crawford,	Piqua,	Ohio,	4
Tiles,—Blocks for Forming	James Molyneux,	Bordentown,	N. J.	11
Tobacco,—Straightening, &c.,	W. W. Justis,	Genito,	Va.	11

Toilet,—Composition for	Sampson American,	Chicago,	Ill.	11
Treadle Connexion for Machin'y,	A. A. Raymond, .	Salem,	Mass.	11
Trip Hammer, .	Alexander Morton,	City of	N. Y.	18
Tuck and Plait Folders, .	Reuben Brady, .	"	"	4
Turning Ovals,—Machines for	I. S. Barber, .	"	"	4
Umbrella Sticks,—Wood for	Jonathan Ball, .	Elmira,	N. Y.	4
Valves,—Slide .	James Millholland,	Reading,	Penna.	25
——— .	John Randall, .	Elmira,	N. Y.	25
Veneers,—Chamfering	George Williamson,	Newark,	N. J.	4
Vulcanized Rubber,—Restoring	D. D. Parmelee, .	Salem,	Mass.	25
Wash-board, .	A. Hoagland, .	Jersey City,	N. J.	11
Washing Machine, .	S. W. Mudge, .	Rome,	N. Y.	18
———	Wm Shafer, .	Ripon,	Wis.	11
——— . .	C. D. and S. M. Ober,	Morrisville,	Vt.	11
Watches, .	E. G. Elliot, .	Elk Horn,	Wis.	11
Wells. &c.,—Rais'g Water from	Joel Lee, .	Galesburg,	Ill.	18
Wheels,—Car .	Wade & Kaye, .	Pittsburgh,	Penna.	4
———,—Tightening Tires on	Everett Bass, .	Calhoun co.,	Ga.	11
Whiffle-trees for Vehicles,	M. C. Chamberlin,	Johnsonsburg,	N. Y.	11
Windmills, .	J. R. Babcock, .	Canandaigua,	"	18
Window Sashes,—Hanging	L. W. Thickstun,	Chatfield,	Minn.	18
——— Shutter Stands,	J. W. Knapp, .	Chester,	N. Y.	4
Wine Presses, .	Wm. S. Kimball,	Rochester,	"	4
Wood-screws, .	George Freeman, .	City of	"	11

EXTENSIONS.

Acids,—Separat. Oleic & Stearic	J. S. Gwynne, .	City of	N. Y.	4
Sewing Machines, .	Elias Howe, Jr., .	Brooklyn,	"	11
Stoves, .	J. H. B. Latrobe,	Baltimore,	Md.	4

ADDITIONAL IMPROVEMENTS.

Corn Planters, .	W. C. Banks, .	Como Depot,	Miss.	4
Hay,—Loading .	T. J. Jolly, .	Olean,	Ind.	4
Stoves, .	G. J. Kingsbury, .	Rochester,	N. Y.	18

RE-ISSUES.

Bags,—Making Paper .	E. W. Goodale, .	Clinton,	Mass.	4
Cameras,—Plate-holder for	A. S. Southworth,	Boston,	"	25
Cloth,—Drying .	B. Sexton, .	E. Windsor,	Conn.	25
Cordage,—Manufacturing	Wm. Joslin, .	Cleveland,	Ohio,	25
Grain Separators, .	J. L. Booth, .	Rochester,	N. Y.	25
Hay Making Machines,	J. C. Stoddard, .	Worcester,	Mass.	11
Lamps, .	M. A. Dietz, .	Brooklyn,	N. Y.	4
——— .	Wm. Fulton, .	Cranberry,	N. J.	25
———,—Vapor .	A. M. Mace, .	Springfield,	Mass.	4
Ovens,—Bakers .	Hiram Berdan, .	City of	N. Y.	11
Printing Presses,—Feeding	S. and G. H. Ferguson,	Malden Bridge,	"	25
Ploughs,—Gang .	Henry Cowing, .	Corpus Christi,	Texas,	11
Railroads,—Sleeping Cars for	Eli Wheeler, .	Elmira,	N. Y.	18
Roofing Compositions,	Henry Lester, .	Cincinnati,	Ohio,	18
Seed Planters (5 Patents),	G. W. Brown, .	Galesburg,	Ill.	11
Steam Engines,—Regulat. Valve	N. C. Travis and others,	Alton,	"	25

DESIGNS.

Sad Irons, .	Thomas Loring, .	Blackwoodt'n,	N. J.	25
Stove,—Plates of a	Horton & Martine,	Philadelphia,	Penna.	25
———,——— Cylinder	" .	"	"	25
———,—Cooks .	W. W. Stanard,	Buffalo,	N. Y.	25
——— .	" .	"	"	25
Stoves, .	N. S. Vedder, .	Troy,	"	4
Washington Irving,—Medallion	Marie L. Livingston, .	City of	"	4

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, November 15, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President, } Present.
Isaac B. Garrigues, Recording Secretary, }

The minutes of the last meeting were read and approved.

Letters were read from Eli W. Blake, Esq., New Haven, Conn.; and Jos. Wharton, Esq., Bethlehem, Penna.

Donations to the Library were received from the Royal Institution, the Royal Astronomical Society, and the Zoological Society, London; the Literary and Philosophical Society, Liverpool, England; the K. K. Geologischen Reichsanstalt, the K. K. Geographischen Gesellchaft, and the Oesterreichischen Ingenieurs Verienes, Vienna, Austria; Frederick Emmerick, Esq., Washington, D. C.; the Providence Athenæum, Providence, R. I.; Samuel Clark, Esq., City of New York; Henry Howson, Esq., and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of October was read.

The Board of Managers and Standing Committees reported their minutes.

Eight resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (14) were proposed, and the candidates proposed at the last meeting (18) duly elected.

Blake Brothers sent a cut and description of their Ore and Stone Breaker, with an invitation to the members to witness its operation at a quarry near Germantown. It consists of a heavy cast iron frame, carrying a movable hinged jaw, operated by a toggle-joint which takes its motion from a lever and a crank of short throw. Every revolution of the crank gives about one-quarter of an inch motion to the end of the jaw, which hangs nearly vertical, and so as to form, in connexion with the frame, a chamber for the reception of the stone. The size of this chamber varies with the size of the machine, being at the top from 10 ins. long by 5 ins. wide, to 20 ins. long by 7 ins. wide; whilst the bottom area, or exit for the broken stone, has the same length as the top, but of such width as may be desired to produce stone of the required size; the adjustment being made by a wedge and screw, or by substituting longer or shorter bars in the toggle-joint.

"The product of these machines per hour, in cubic yards, of fragments, will vary considerably with the character of the stone broken. Stone that is granular in its fracture, like granite and most kinds of sandstone, will pass through more rapidly than that which is more compact in its structure. The kind of stone being the same, the product per hour will be in proportion to the width of the jaws, the distance between them at the *bottom*, and the speed.

"The proper speed is about 200 revolutions per minute; and to make good road metal from hard compact stone, the jaws should be set from 1¼ to 1½ ins. apart at the bottom. For softer and for granular stones they may be set wider."

The following table will give an idea of the capacity of the breaker.

Size of chamber at top.	Product per hour.	Power required.
10″ × 5″	3 cubic yards.	6 horses.
15 × 5	4½ "	9 "
20 × 7	6 "	12 "

These machines are in use at the Central Park and new Reservoir, N. Y., Cooper & Hewitt's blast furnace, and at Graff, Bennett & Co.'s, Pittsburgh, and are said to give satisfaction in all cases.

Mr. Joseph Wharton, of the Lehigh Zinc Works, sent an ingot of pure Zinc for the inspection of the members. The ore from which it was made is obtained from the mines of the Lehigh Zinc Co., near Bethlehem, Penna., at which town the works are located. About 30 tons of metal are produced weekly, and when the furnaces are all in operation the production will be increased to two thousand tons per annum. All the articles required in the manufacture of the zinc are made upon the premises: as retorts, muffels, fire-bricks, &c., of ingredients brought from the surrounding country, no foreign material being used. This zinc is claimed to be equal to the best distilled zinc sold by manufacturing chemists. Prof. Booth, U. S. Mint, Prof. Bruel, Yale College, Mr. C. W. Eliot, and Mr. F. W. Storer, have examined and approve its quality.

A Rain Conductor, taken from the Farmers Market, was placed upon the table. Several of the conductors at'ached to the Market were, shortly after a heavy rain storm, found to be collapsed. This may have been owing to a sudden stoppage of the conductors near the top by shavings, and the consequent formation of a vacuum by the discharge of the water below the obstruction. Or, the water in falling through the conductor has, in obedience to the law of gravity, become attenuated more and more as it neared the ground, whilst the air has been carried along with its current, causing a partial vacuum, which the material of the conductor was not able to withstand. As a parapet wall surrounds the roof, a head of water was above the entrance to the conductors, and consequently no air could enter to supply the place of that drawn off, and a collapse resulted. The remedy would have been—perforations at intervals.

The President, at the request of the Committee on Meetings, gave an account of two remarkable instances illustrating the tendency of electrical discharges to disperse in different directions, when conducting bodies situated near its path are presented.

One of these was that of the destruction of several panels of a post and rail fence, on the farm of Israel W. Morris, situated near the western part of the city. The lightning appeared to have struck a

maple tree standing on a small knoll in the line of the fence, and descending along the bark of the tree, without apparent injury, to the level of the rails near the ground, diverged in opposite directions along the fence, splitting the rails and bursting open the posts for the distance of eight panels each side, where it seems to have been conveyed into the earth.

The other case was that of a stroke of lightning on the line of telegraph belonging to the City Gas Works. In this instance, the flash was seen to dart upon a cherry tree standing about 60 feet south of the line of wires, and then to pass along the line in opposite directions, having the appearance of balls of fire leaping from pole to pole. The portion of the charge passing eastward was traced for the distance of 1500 feet by the destruction of the poles, many of which were so shattered as to let the wires drop to the ground, and others splintered more slightly. Going west, the poles were uninjured, the charge reaching the ground in that direction through the ground wire and the lightning protectors of the instruments at the First Ward station of the Gas Works, distant about 3100 feet from the point of reception. The instruments that were connected with the line were uninjured, but others which were not connected were greatly damaged; the copper wires being fused, and the glass case covering one of them shattered as if by an explosion from within.

The instruments referred to by the President were placed on the table for inspection by the members.

METEOROLOGY.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A.M.

October.—The temperature of October was over four degrees higher than that of October, 1859, and about half a degree above the average temperature of the month for the last ten years. The warmest day of the month was the 2d, of which the mean temperature was 69°, and the thermometer reached the maximum (79°) on the same day. The 14th of the month was the coldest day, the mean temperature being 43½°. The temperature was lowest (36°) on the night of the 14th, during a storm of rain. On the same day, on the north of the city, and throughout northern Pennsylvania and southern New York, the first snow of the season fell. On the 15th, 16th, and 17th, the temperature increased gradually, and from the 18th till the end of the month, remained at about an average of 57°, with but little range, at no time being below 44°.

Both the daily oscillation and the mean daily range of temperature were less than for the same month last year, though they were slightly above the average for ten years.

The force of vapor and the relative humidity were above the average for the first time since last May; the increase in the former being more marked at 9 P. M., and in the latter at both 2 and 9 P. M.

Rain fell at Philadelphia on thirteen days of the month, to the ag-

gregate depth of 4·685 inches, which is nearly two inches above the average for the month, and an inch and a half more than fell in October, 1859. It is more than fell in any other October for the last ten years; the nearest approach to the amount was in October, 1853, when 3·47 inches fell.

The pressure of the atmosphere was two-hundredths of an inch greater than the average, and nearly one-tenth of an inch greater than in October, 1859. The barometric column stood highest on the morning of the 1st of the month, when it indicated 30·275 inches, though the average height for a day was greatest on the 28th. It was lowest (29·312 inches) on the afternoon of the 8th.

There was but one day of the month on which the sky was completely clear, or free from clouds; and there were six days on which the sky was completely covered with clouds, at the hours of observation.

The winds during the month were but one degree nearer the west than in September, and still very nearly as far south of west as the resultant for the month for the last ten years is north of west.

The earthquake which extended throughout Canada and over all of the Eastern States, on the morning of Wednesday, the 17th of October, was not felt, or, at any rate, not noticed, at Philadelphia.

A Comparison of some of the Meteorological Phenomena of October, 1860, *with those of October,* 1859, *and of the same month for ten years, at Philadelphia.*

	Oct., 1860.	Oct., 1859.	Oct., 10 years.
Thermometer.—Highest,	79°	81·5°	90°
" Lowest,	36	30·0	28
" Daily oscillation,	16·10	18·10	15·60
" Mean daily range,	5·80	5·90	5·60
" Means at 7 A. M.,	51·58	46·98	50·97
" " 2 P. M.,	63·29	59·11	63·03
" " 9 P. M.,	55·61	50·87	55·17
" " for the month,	56·83	52·32	56·39
Barometer.—Highest,	30·275 in.	30·193 in.	30·410 in.
" Lowest,	29·312	29·470	29·012
" Mean daily range,	·119	·140	·143
" Means at 7 A. M.,	29·963	29·864	29·937
" " 2 P. M.,	29·906	29·823	29·895
" " 9 P. M.,	29·938	29·850	29·915
" " for the month,	29·936	29·845	29·916
Force of Vapor.—Means at 7 A. M.,	·321 in.	·259 in.	·312 in.
" " " 2 P. M.,	·363	·274	·344
" " " 9 P. M.,	·354	·280	·316
Relative Humidity.—Means at 7 A. M.,	80 per ct.	75 per ct.	78 per ct.
" " " 2 P. M.,	61	50	56
" " " 9 P. M.,	77	69	73
Rain, amount in inches,	4·685	3·210	2·781
Number of days on which rain fell,	13	7	9
Prevailing winds,	s.75°58′w·069	n.75°21′w·405	n.73°32′w·255

Abstract of Meteorological Observations for September, 1860; made in Philadelphia, Franklin, and Somerset Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.

1860. Sept.	Barometer. Mean.	Barometer. Mean daily range	Thermometer. Mean.	Thermometer. Daily oscillation.	Thermometer. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.
1	29·817	·125	71·0	22	4·2	·459	46		N W.
2	30·087	·270	65·8	20	5·2	·307	38		N W.
3	30·152	·065	68·2	18	2·3	·396	44		(var.)
4	30·160	·071	70·0	25	2·8	·445	43		(var.)
5	30·017	·143	75·3	20½	5·3	·617	53		S S W.
6	29·974	·043	75·3	14	2·0	·700	66	0·072	S S W.
7	29·953	·025	78·5	20	3·2	·743	58		S W.
☾ 8	29·755	·198	80·3	21	2·2	·822	56	0·032	S W.
9	29·910	·173	62·8	18	17·5	·313	47		N.
10	29·934	·079	62·7	24	5·5	·348	47		S W.
11	29·812	·122	63·7	10	4·3	·435	68	0·165	N E.
12	29·783	·115	55·7	12	8·0	·224	43	0·127	N W.
13	30·061	·268	57·8	22	5·8	·240	36		N W.
14	30·252	·201	63·5	25	5·7	·325	39		S W.
● 15	30·228	·029	66·0	24	2·5	·455	47		S W.
16	30·017	·211	68·8	24	2·8	·504	48		S W.
17	29·894	·123	70·5	16	5·7	·587	68		S S W.
18	29·972	·078	72·7	20½	2·5	·556	54		S W.
19	29·955	·025	74·7	18	2·0	·619	59		S E.
20	29·682	·273	74·3	14	1·7	·769	78	2·056	S W.
☽ 21	29·871	·188	60·7	17	13·7	·260	41		WNW
22	30·073	·202	60·8	22	4·8	·280	38		S W.
23	30·004	·069	68·7	23	7·8	·502	51		S W.
24	29·936	·068	69·7	22	1·3	·445	43		(var.)
25	29·676	·260	70·8	15	2·8	·556	54	0·085	S W.
26	29·992	·316	60·3	14	10·5	·282	44		W.
27	30·135	·143	51·5	10	8·8	·293	73	0·370	W.
28	30·034	·123	55·8	18	5·3	·281	47		N W.
○ 29	30·232	·198	50·3	17	5·5	·161	35		N W.
30	30·304	·072	48·3	10	3·3	·187	49		N W.
Means	29·989	·143	65·8	18	5·2	·437	50	2·907	s 74° w

CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.

1860. Sept.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	29·216	66·7	4·0	·385	52		W.
2	29·447	63·0	3·0	·398	56		(var.)
3	29·541	68·3	5·3	·449	61		E.
4	29·507	70·3	2·0	·581	72		E.
5	29·368	73·0	3·3	·677	66		E.
6	29·331	73·0	3·3	·744	86	0·575	E.
7	29·300	74·3	2·7	·772	80		E.
☾ 8	29·138	77·0	2·7	·816	75	1·180	(var.)
9	29·379	63·3	13·7	·330	53		(var.)
10	29·287	60·7	6·7	·389	63		W.
11	29·175	63·3	3·0	·398	56		(var.)
12	29·274	53·0	10·7	·225	57		(var.)
13	29·500	56·0	3·7	·314	53		W.
14	29·614	58·3	3·0	·425	64		S E.
● 15	29·554	62·7	3·7	·459	58		S E.
16	29·572	66·7	4·0	·601	65		E.
17	29·246	65·7	6·3	·577	84	0·085	(var.)
18	29·335	67·0	2·7	·608	80	0·210	E.
19	29·265	71·0	4·0	·704	81		S E.
20	29·064	71·3	1·7	·704	81	2·477	W.
☽ 21	29·273	58·7	12·7	·427	77		(var.)
22	29·380	57·0	7·7	·303	46		(var.)
23	29·345	65·0	8·0	·505	56		W.
24	29·222	66·0	2·3	·532	63	0·374	W.
25	29·051	67·7	1·7	·462	55		W.
26	29·416	60·7	7·0	·314	53		E.
27	29·464	52·7	8·3	·375	93	0·234	(var.)
28	29·436	54·7	8·7	·297	55		E.
○ 29	29·591	48·7	5·3	·295	68		E.
30	29·637	48·0	2·7	·308	79		E.
Means	29·357	63·5	5·0	·480	66	5·135	s 45° E

SOMERSET, Somerset Co. Lat. 40° N. Long. 79° 3′ W. Height 2195 feet. GEO. MOWRY, Observer.

1860. Sept.	Barom. Mean.	Thermom. Mean.	Thermom. Mean daily range.	Force of vapor. 2 P.M.	Relative humidity. 2 P.M.	Rain.	Prevail'g winds.
	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
1	27·678	60·3	5·7	·408	50		W.
2	27·831	59·3	4·3	·442	54		WNW
3	27·895	63·7	6·3	·448	61		S E.
4	27·870	66·0	1·7	·567	67		S E.
5	27·791	68·7	4·0	·771	78		S W.
6	27·770	73·3	4·7	·772	71		E S E.
7	27·756	74·7	1·3	·826	70	0·027	S W.
☾ 8	27·629	73·0	2·3	·859	79	1·372	W.
9	27·741	52·3	20·7	·281	58		N.
10	27·691	56·0	9·7	·455	63		W.
11	27·627	53·7	2·3	·366	52	0·375	W.
12	27·718	46·7	9·0	·270	72		N W.
13	27·896	47·7	4·3	·295	59		N W.
14	27·975	55·0	10·0	·408	50		S E.
● 15	27·948	60·3	5·0	·491	53		?
16	27·761	66·0	5·7	·526	57	0·221	S W.
17	27·679	60·0	6·0	·462	65		S E.
18	27·723	63·7	4·3	·581	71		S S E.
19	27·697	67·0	3·3	·594	63		S S E.
20	27·535	62·3	6·7	·534	59	0·106	(var.)
☽ 21	27·681	49·3	13·0	·282	54		W.
22	27·767	55·0	9·7	·370	49		S W.
23	27·776	62·7	7·7	·518	60		W.
24	27·650	64·3	2·3	·520	55		W S W
25	27·536	64·7	3·7	·614	68	0·058	W.
26	27·831	49·0	15·7	·309	60		W.
27	27·821	45·0	6·0	·273	84	0·409	S E.
28	27·812	48·3	6·0	·242	52		N W.
○ 29	27·921	44·0	7·0	·254	53		S W.
30	27·920	41·7	11·7	·221	83		E.
Means	27·764	58·5	6·7	·465	62	2·570	s 63° w

1860.	Gettysburg, Adams Co. Lat. 39° 49′ N. Long. 77° 18′ W. Ht. 624 ft. Prof. M. Jacobs, Obs.					Harrisburg, Dauphin Co. 40°10′, N. 76°50′, W. Ht. 300 ft. John Heisely, M.D., Obs.			Shamokin, Northumberland Co. 40° 45′ N. 76° 30′ W. Height, 700 ft. P. Friel, Obs.				Fleming, Centre Co. 40° 55′ N. 77° 53′ W. Ht., 780 feet. S. Brugger, Obs.				Erie, Erie Co.—Lat. 42° 8′ N. Long. 80° 12′ W. Height about 640 feet. Benjamin Grant, Obs.						
	Barom.	Thermom.		Rain.	Prevail'g winds.	Barom.	Thermom.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Barom.	Thermom.		Force of Vapor.	Relative humidity.	Rain.	Prevail'g winds.
Sept.	Mean.	Mean.	Mean daily range.						Mean.	Mean daily range.			Mean.	Mean daily range.			Mean.	Mean.	Mean daily range.	2 P. M.	2 P. M.		
	Inch.	°	°	Inch.	Direc.			Direc.	°	°	Inch.	Direc.	°	°	Inch.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.
	29·405	65·3	4·7		N W.			N W	59·0	11·0		(var.)	62·0	4·3		(var.)	29·4·3	63·3		·440	64		N W.
	29·646	63·7	3·0		N E.			N.	57·3	1·7		E.	58·7	5·3		W.	29·518	61·7	1·7	·468	60		E.
	29·754	66·3	2·7		(var.)			E.	63·3	6·0		S E.	63·0	6·3		S W.	29·608	65·7	4·0	·537	61		S.
	29·698	66·8	0·7		S S W.			(var.)	66·0	5·3		(var.)	68·0	8·3	0·080	S W.						0·110	S.
	29·544	75·0	9·0		S S W.			(var.)	73·7	7·7	0·121	(var.)	74·0	6·0		W.							S.
	29·533	75·0	4·0	0·098	S.			(var.)	74·0	2·3		E.	73·0	3·7	0·675	W.	29·340	75·7		·741	70	} 0·70	W.
	29·490	76·3	3·3		(var.)			S W.	73·3	3·3		S E.	73·3	3·0		(var.)							N.
	29·335	77·7	2·0	1·060	(var.)			S W.	76·0	3·3	0·204	W.	71·3	5·3	0·410	W.							
	29·519	57·7	20·0		N.			N.	57·3	18·7		W.	54·3	17·0		N W.							
	29·486	57·7	7·3		S S W.			S W	65·0	7·7		(var.)	56·3	9·3		S E.							
	29·383	61·3	3·7	0·025	S W.			S W.	60·0	5·3		W.	57·7	7·3	0·220	N W				·446	56		N.
	29·466	62·3	9·0		N W.			N W.	49·3	10·7	0·400	W.	52·7	6·3		N W.	29·438	62·7		·214	39		N.
	29·700	64·3	4·7		N W.			N W.	51·7	5·3		W.	52·0	1·3		N W.	29··70	55·7	8·0	·323	47		W.
	29·841	67·3	5·7		S W.			S W	64·0	9·0		W.	65·7	7·7		W	29··62	66·0	10·3	·298	46		W.
	29·777	61·3	4·0		S.			S W.	59·3	5·3		(var.)	68·0	2·3		(var.)	29·46[illegible]	73·3	7·3	·411	56		S W.
	29·548	66·7	4·7		(var.)			S W.	67·7	8·3		S E.	63·0	6·0		W.	29·256	66·7	6·0	·534	61		S W.
	29·482	65·3	7·3		S S W.			(var.)	62·7	10·7		E.	64·0	5·7	0·186	S W.	29·313	61·7	7·0	·4[illegible]0	55		N.
	29·536	60·3	4·0	0·166	(var.)			N E.	69·3	12·3	0·185	E.	65·3	5·3		(var.)	29·321	61·7	3·3	·470	58		(var.)
	29·492	70·7	1·7	0·040	S S W.			S W	70·7	6·0	0·052	E.	71·0	5·7		W.	29·316	68·0	6·3	·472	57		W.
	29·277	70·3	2·0	0·240	S.			(var.)	69·3	1·3	0·250	(var.)	66·3	5·3	0·210	S W.	29·124	60·3	7·7	·424	64	0·140	(var.)
	29·434	57·3	10·3		W.			N W	64·0	13·3		(var.)	51·7	14·7		N W.	29·260	51·3	9·0	·333	46	1·165	S W.
	29·612	60·0	5·0		S S W.			W.	64·3	12·3		(var.)	55·3	9·7		N W	29·265	62·7	11·3	·360	50	0·030	S W.
	29·661	65·7	9·7		S.			S W.	66·7	12·3		W.	63·3	8·0		(var.)	29·322	64·0	1·3	·457	58	0·150	N E.
	29·442	66·3	1·3		S W.			S W.	67·0	1·0		E.	65·0	3·0		(var.)	29·139	70·7	0·7	·424	54		S W.
	29·242	60·7	3·3	0·620	N W.			N W.	62·0	13·0	0·600	W.	65·7	8·0	0·300	W.	29·180	62·3	9·3	·328	47	0·770	(var.)
	29·608	57·7	12·0		(var.)			W.	59·7	5·3		W.	58·0	7·7		N W.	29·463	56·2	6·0	·261	40		N W
	29·717	49·0	5·7	0·186	(var.)			(var.)	49·3	9·3		S E.	54·0	2·7		S E.	29·493	54·5	8·3	·314	46		S E.
	29·662	53·7	4·7		W.			N W.	53·7	4·3		(var.)	50·0	6·7		W.	29·545	52·3	6·0	·187	33	0·010	N E.
	29·833	49·0	4·7		N W.			N.	42·7	11·0		(var.)	49·0	4·3		N W.	29·686	40·0	6·3	·196	34		E.
	29·809	46·3	5·3		N W.			N E.	45·0	3·3		(var.)	45·0	4·0		S E.	29·627	48·7	5·3	·216	30		E.
	29·560	62·0	5·0	2·780	S 72° W			S 66° W	[illegible]7	7·7	1·810	S 4° W	60·6	6·4	1·960	N 80° W						3·165	N 74° W

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